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THE ART OF DRAWING IN PERSPECTIVE

BRITISH MUSEUM

Thomas Biggar

THE ART OF DRAWING IN PERSPECTIVE MADE EASY

To thoſe who have no previous KNOWLEDGE of
the MATHEMATICS.

By JAMES FERGUSON, F. R. S.

ILLUSTRATED WITH PLATES.

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PREFACE.

IN my infirm ſtate of health, a ſituation that is very apt to affect the mental faculties, I thought my late book of Mechanical Exerciſes would have been the laſt I ſhould ever publiſh. But, as I have been conſtantly accuſtomed to an active life, and to conſider idleneſs as an inſupportable burden, I have, of late, amuſed myſelf at intervals, as my uſual buſineſs would permit, with ſtudying *Perſpective*; which is an art that every one who makes drawings, were it but for plates (eſpecially of ſolid figures) in books, ſhould be acquainted with. And indeed I drew the figures which

are

are now engraved for this Book, with no other view than to inſtruct others verbally by, who came to me to learn ſomething of that branch of ſcience, without having the leaſt thought of ever laying them before the Public.

But, upon ſhewing theſe drawings accidentally to ſome friends, they expreſſed their deſire that I ſhould write a deſcription of the rules by which they were delineated. I complied with their deſire, and it is entirely owing to their partiality to me, that I have conſented to this publication.

I need not obſerve how requiſite it is for painters who put groupes of figures together, but alſo for thoſe who draw landſcapes, or figures of machines and engines for books, to know the rules of Perſpective. The want of this branch of knowledge is the reaſon why we not only ſee very bad and diſtorted figures of machines and engines in printed books, but alſo why we ſee many hiſtorical paintings, in which the different pictures of men, women, hills, houſes, birds, and beaſts, are put together without any regard to what painters call *keeping*; which is the ſame thing as *repreſenting* objects in the ſame manner that they appear to the eye, at different diſtances from it.

I ſhall only mention two inſtances in the work of one of the greateſt painters that ever exiſted;--I mean the celebrated RAPHAEL URBIN.

Every man is ſenſible, that, if he ſhould ſtand by the ſea-ſide, and look at a boat with men in it at ſome diſtance, he could not diſtinctly ſee the features of thoſe men, much leſs the wrinkles and marks of the muſcles in their faces or bare arms. And if he were in a boat, at ſome diſtance from the land, he could not perceive the eyes and beaks of fowls on the ſhore.

Yet ſo it is, that, in one of the famous *Cartons* of RAPHAEL, repreſenting the miraculous draught of fiſhes, the men in each of the two boats appear of full ſize, the features of their faces ſtrongly marked; and the boats are repreſented ſo ſmall, and the men ſo big, that any one of them appears ſufficient to ſink either of the boats by his own bare weight; and the fowls on the ſhore are likewiſe drawn ſo big, as to ſeem very near the eye of the obſerver; who could not poſſibly, in that caſe, diſtinguiſh the features of the men in the diſtant boats. Or, ſuppoſing the obſerver to be in either of the boats, he could not ſee the eyes or beaks of the fowls on ſhore.

The other inſtance is of a very capital miſtake in Raphael's hiſtorical picture of our SAVIOUR's transfiguration on the Mount; where he is repreſented with thoſe who were then with him, almoſt as large as the reſt of his diſciples at the foot of the Mount, with the father and mother of the boy whom they brought to be cured: and the mother, though on her knees, is more than half as tall as the Mount is high. So that the Mount appears only of the ſize of a little hay-rick, with a few people on its top, and a greater number at its bottom on the ground: in which caſe a ſpectator at a little diſtance could as well diſtinguiſh the features of thoſe on the top as of thoſe on the ground. But upon any large eminence, deſerving the name of a Mount, *that* would be quite impoſſible.---My only reaſon for mentioning theſe extraordinary particulars, is to ſhew, how neceſſary it is for painters to be well acquainted with the rules of Perſpective.

I am far from conſidering the following Work as a complete ſyſtem of *Perſpective*, for *that* would require a very large volume. But I think I may venture to ſay, that, when the learner is fully maſter of what is there contained, he will not find any great difficulty in proceeding to what length he pleaſes in the attainment of this ſcience, without any further aſſiſtance.--Or, if he ſhould grow tired, and be weary of going on according to the rules, he may make uſe of the Perſpective Machine deſcribed and delineated at the end of this ſmall tract, by which he may draw every thing equally eaſy that he ſees before him, without knowing any rule at all. But I hope there are very few who will have recourſe to ſuch an unſcientific method.

It is very probable, that thoſe who already underſtand Perſpective, if they take the trouble of reading this ſmall Treatiſe, may think I have been rather too verboſe in moſt of my deſcriptions. I only requeſt of ſuch to conſider,

ſider, that I never wrote any thing for thoſe who are well ſkilled in the few branches of ſcience whereof I have treated; but only for thoſe who wiſh to attain a moderate knowledge of them; and to ſuch, I think, every thing ought to be made as plain and eaſy, and be as minutely deſcribed, as is poſſible.

Perſpective made Eaſy.

CHAP. I.

The THEORY *of* PERSPECTIVE.

1. PERSPECTIVE is the art of drawing the reſemblance or pictures of objects on a plane ſurface, as the objects themſelves appear to the eye.---Thus, ſuppoſe a perſon at a window looks through an upright pane of glaſs at any object beyond it; and, keeping his head ſteady, draws the figure of the object

upon the glaſs, with a black lead pencil, as if the point of the pencil touched the object itſelf; he would then have a true repreſentation of the object in perſpective, as it appears to his eye.

In order to this, two things are neceſſary: firſt, that the glaſs be laid over with ſtrong gum-water, which, when dry, will be fit for drawing upon, and will retain the traces of the pencil: and, ſecondly, that he looks through a ſmall hole in a thin plate of metal, fixed about a foot from the glaſs, between it and his eye, and that he keeps his eye cloſe to the hole; otherwiſe he might ſhift the poſition of his head, and conſequently make a falſe delineation of the object.

Having traced out the figure of the object, he may go over it again with pen and ink; and, when that is dry, put a ſheet of paper upon it, and trace it thereon with a pencil: then, taking away the paper, and laying it on a table, he may finiſh the picture, by giving it the colours, lights, and ſhades, as he ſees them in the object itſelf; and then he will have a true reſemblance of the object.

2. The nearer that any object is to the eye, the bigger it appears: the farther from the eye, ſo much the leſs, both in height and breadth.

3. All objects become viſible by the rays of light which flow from them into the eye. Theſe rays paſs through the pupil, and fall upon the retina,

which is a fine expanſion of the optic nerve, interwoven like net-work in the back-part or bottom of the eye; and there the rays form a picture of the object, whoſe apparent bulk depends upon the ſize of ſuch picture, ſo formed upon the retina.

In Fig. 1. of Plate I. let *PbdcaP* be the eye, *P* the pupil, or round black opening in the middle or fore-part of the eye, through which the rays of light enter, and proceed to the retina or back-part *b c d a*, where they are intercepted, and form the pictures of the objects from which they flow. Every point of the object throws off rays of light in all manner of ſtraight-lined directions; and therefore, every viſible point of an object will ſend ſome rays through the pupil into the eye; and theſe rays, falling upon the retina, will form all the correſponding points of the picture or image of the object thereon. The rays are coloured according to the colours of the objects they flow from, and give the like colours to its picture formed in the eye.

4. To ſhew that the pictures of objects are thus formed upon the retina, take the eye of a ſheep or bullock, newly killed, and cut off all the opake part from the outſide of the back of the eye, till the tranſparent retina appears: then hold up the eye between your own eye and any object, with the fore-part of the eye toward the object, and you will ſee a fine inverted picture of the object on the retina, having all the colours of the object itſelf.

5. In Fig. 1. let *A e B* be an object, whoſe diſtance from the eye is *P e*. A ray *A P a* from the top of the object, paſſing through the pupil *P* of the eye, and going on to the retina, forms the picture or image of the point *A* thereon, at *a*; and a ray *B P b*, from the foot of the object, paſſing through the pupil *P*, and going on to the retina, forms the image of the point *B* at *b* on the retina.---All the intermediate points of the object, from *A* to *B*, ſend rays of light into the eye, which form all the intermediate points of the image between *a* and *b* in the eye. So that the image of the object is inverted in the eye; and its whole length is included between the points *a* and *b* on the retina. Thoſe who want to know why we ſee the objects themſelves in an inverſe poſi-

tion to that of their pictures in the eye, muſt read what optical writers have ſaid on that ſubject.

Let the ſame object be placed twice as far from the eye, as at *C D*; then the diſtance *P f* will be double the diſtance *Pe*. The ray *CPc* forms the image of the top *C* at *c* on the retina, and the ray *DPd* forms the image of the bottom-point *D* of the object at *d* on the retina.--Now it is plain, that as the ſpace between *c* and *d* is only equal to half the ſpace between *a* and *b*, the image of the object will be but half as long upon the retina, when the diſtance *P f* of the object is twice as great as its diſtance *P e* was before. ---And thus, by removing the object further and further from the eye, or removing the eye further and further from the object, it would ſeem at laſt to be no bigger than a mere point, becauſe the angle under which it was then ſeen would be next to nothing.

6. An ANGLE is formed by two lines approaching toward each other till they meet; and the point where they meet is termed *the angular point*. Thus, in Fig. 1. the lines *AP* and *B P* tending toward one another, form an angle; and the point where they meet at *P* is the angular point: and whether theſe lines be long or ſhort, it makes no alteration in what is termed *the meaſure of the angle*; as we ſhall ſhew in the next ſection.

In deſcribing an angle, three letters are generally uſed, the middle letter always meaning the angular point where the two lines meet.--Thus, *APB* denote the angle formed by the two lines *AP* and *BP*, meeting at *P*; and *CPD* denote the angle formed by the two lines *CP* and *DP*, meeting at *P*.-- In this caſe, as the object *A eB* ſubtends (or is ſeen under) the angle *A P B*, and the object *C f D* is ſeen under the angle *C P D*, the former is called the angle of viſion of the object *AeB*, and the latter the angle of viſion of the object *CfD*. But, as the lines *CP* and *DP* fall within the lines *A P* and *B P*, the angle of viſion of *C f D* is leſs than the angle of viſion of *AeB*; and juſt as much leſs as the diſtance of the object *C f D*, from the eye, is greater than the diſtance of the object *A e B* from it.--So that the apparent height (or breadth) of any object is directly as the meaſure of the angle under which it is ſeen.

7. If a circle, of any diameter whatever, be divided into 360 equal parts or degrees, and the angular point be at the center, the number of degrees between the two lines which form the angle is the meaſure thereof. Thus, in Fig. 2. of Plate I. the lines *AC* and *B C* form the angle *ACB*; of which, the point *C* at the centre of the ſemicircle *dABe* is the angular point; and the number of degrees of the ſemicircle contained between the points *A* and *B*, in the arc *AB*, is the meaſure of the angle *ACB*.

Let the ſemicircle be divided into three equal parts, as *d A*, *A B*, and *Be*; then each part will contain 60 degrees (the whole ſemicircle containing 180) and that will be the meaſure of either of the three angles *d C A*, *A C B*, or *B Ce*.

Join the points *A* and *B* by the ſtraight line *A B*, and a triangle will be formed by the three lines, *CA*, *AB*, and *BC*, all of equal length; and all the three angles at *A*, *B*, and *C*, will be equal, each containing 60 degrees. --So likewiſe, in the leſſer ſemicircle *k a b l*, the lines *a b b*, and *C a* are of equal length; and each angle, at *C*, *a*, and *b*, contains 60 degrees.

8. Any triangle whoſe ſides are all equal, is called *an equilateral triangle*; and the angle oppoſite to either ſide thereof contains 60 degrees.

9. *To make an equilateral triangle upon a line of any given length*, as ſuppoſe the line *AB* (Plate I. Fig. 2). take the length *AB* between the points of your compaſſes, and, with that extent,

tent, ſet one foot on the end of the line at *A*, and with the other foot deſcribe the arc *f C g*; then, without altering the compaſſes, ſet one foot on the end *B*, and with the other foot deſcribe the arc *h Ci*: laſtly, from the ends *A* and *B* draw the two lines *A C* and *B C* to the interſection of theſe arcs at *C*; and you will have an equilateral triangle, formed by the three lines or ſides *AB*, *BC*, and *CA*; and each ſide will ſubtend an angle of 60 degrees.--In the ſame manner may an equilateral triangle be made upon the given line *a b*, by the lines *b C* and *Ca*.

10. No object can be wholly and diſtinctly ſeen (if the eye be kept ſteady while looking at it) under a larger angle than that of 60 degrees. --

--Thus, an eye at *C* may ſee the whole line or object *A B* (or *a b*) without moving or ſtraining, when the diſtance of the eye from each end of the line is juſt equal to the length of the line, or object.--And as this is generally reckoned to be a good angle of viſion, we ſhall keep generally by it, in the following practical part of this Work, where the repreſentations of large objects are delineated. But it will not do ſo well in repreſenting ſmall objects, which are better ſeen under a ſmaller angle than that of 60 degrees: for, when a perſon looks at a common drinking-glaſs, or a die, he never brings it ſo near to his eye (unleſs he be very near-ſighted) as to view it under ſo large an angle as that of 60 degrees; becauſe experience teaches him, that he can ſee it better under a ſmaller angle; that is, when at a greater diſtance from his eye.---Thus, the ſmall object *a b* will be better ſeen by an eye at *D*, viewing it under an angle of 30 degrees (as *a D b*), than if his eye were only at half that diſtance at *C*, viewing the ſame object *ab* under an angle (*aCb*) of 60. And therefore, in delineating the perſpective figures of ſmall objects, the artiſt ſhould always ſuppoſe the obſerver to be ſo far off from the object, as to be viewing it under a leſs angle than that of 60 degrees: and then the perſpective picture will appear more natural, and conſequently ſo much the more pleaſing to the eye.

11. When a perſon ſtands right againſt the middle of one end of a

long avenue or walk, which is ſtraight, and equally broad throughout; the ſides thereof ſeem to approach nearer and nearer to each other as they are further and further from his eye, as the angles under which their different parts are ſeen become leſs and leſs, according as the diſtance from his eye increaſes (§ 2. and 5.); and if the avenue be very long, the ſides of it at the fartheſt end will ſeem to meet: and *there*, an object that would cover the whole breadth of the avenue, and be of a height equal to that breadth, would appear only to be a mere point.

Thus, in Fig. 3. of Plate I. let *AB* be part of one ſide of a long avenue, *DC* as much of the other ſide thereof, and theſe ſides be parallel to each other; and ſuppoſe the avenue to be divided into equal ſquares, as *AefD*, *eghf*, *ghik*, &c. A perſon ſtanding at *O* will ſee theſe two ſides as if they were gradually approaching toward one another, as in Fig. 4; and the ſquares will ſeem to diminiſh in ſize as they are further and further from his eye. So that the firſt ſquare *AefD* in Fig. 3. will appear as *AefD* in Fig. 4. the ſecond ſquare *eghf* in Fig. 3. will appear as *eghf* in Fig. 4. and ſo on till the laſt ſquare of the avenue, produced to the utmoſt bounds of ſight, would vaniſh into a point, as *S* in Fig. 4. where the ſides *AS* and *DS* meet.

12. The point *S*, where the parallel ſides of the avenue ſeem to meet, is called *The point of Sight*; the point *O*,

where the obſerver's eye is placed, is called *The Place of the Obſerver:* the line *S P*, paſſing through the point of ſight, is called *The Horizon*; and a point taken therein, either to the right or left hand from *I*, and as far from *S* as *O* is from S, is called *The Point of Diſtance.*----N. B. In whatever point the obſerver's eye is ſuppoſed to be placed, either for a direct or oblique view of the ſide of the object that is neareſt to him, *a ſtraight line drawn from the point of ſight to his eye muſt be perpendicular to the horizon*; which will be nearer to the eye, or further from it, as the obſerver is ſuppoſed to ſtand upon lower or higher ground.

CHAP.

CHAP. II.

The PRACTICE *of* PERSPECTIVE.

OPERATION I.

To put a Square in Perſpective, as viewed by an Obſerver ſtanding right againſt the Middle of one of its Sides, and having his Eye above the Plane of the Square.

13. IN Fig. 5. of Plate I. let *ABCD* be a ſquare, viewed by an obſerver at *O*, who ſees the ſide *A D* (next to him) under the angle *A C D* of 60 degrees (§ 10).

Make *AD* in Fig. 6. equal to *AD* in Fig. 5. At any convenient diſtance, draw the horizon *SP* parallel to *AD*. Take *O*, the place of the obſerver, according to the rule in § 9.; and from the point *O*, make *OS* perpendicular to *SP*, meeting it in *S*, which ſhall be the point of ſight (§ 12.).

Take *O S* in your compaſſes, and ſetting one foot in *S*, deſcribe the quadrant *(OpP)* of a circle, meeting the horizon in *P*, which, in all caſes, ſhall be the true point or diſtance (§ 12.).

From *A* and *D* (the ends of the ſide of the ſquare next the obſerver at *O)* draw the ſtraight lines *AS* and *DS* to the point of ſight *S*: then, from *A*, draw the ſtraight line *AP* to the point of diſtance *P* in the horizon, cutting the line *DS* in the point *C*: this done, draw *BC* parallel to *AD*; and *ABCD* will be a true perſpective repreſentation of the firſt ſquare *A B C D* in Fig. 5. as ſeen by an obſerver at *O*.

Remark. If the obſerver (Fig. 6.) had ſtood further than *O* from the ſide *AD* of the ſquare, as ſuppoſe at *o*, he would have ſeen that ſide under a leſs angle than 60 degrees; as the angle *A o D* is leſs than the angle *A O D*: and then, the point of diſtance muſt have been at *d* in the horizon; becauſe the point of diſtance in the horizon muſt *always* be taken as far from the point of ſight therein, as the place of the obſerver (*O* or *o*) is from the point of ſight, as we ſhall prove in § 14.; and that, if the point of diſtance in the horizon be taken either nearer to or further from the point of ſight that the diſtance of the obſerver is ſuppoſed to be from that point, there will unavoidably be a falſe perſpective repreſentation of the object.

For, ſuppoſe the placing of the point of diſtance in the horizontal line be left to the diſcretion of the artiſt, as is generally done by writers on the ſcience of perſpective, and that he had put it at *e* (Fig. 6.) in the line *SP*; then, a ſtraight line drawn from *A* to *e* would have cut the line *DS* in the point *h*; and *g h* (parallel to *A D*) would have been the top of the ſquare *AghD*; but it is plain to the eye and judgment, that *AghD* would have been a very bad and unnatural perſpective repreſentation of the ſquare *ABCD* in Fig. 5. Or, ſuppoſing the point of diſtance (Fig. 6.) to have been taken at *f*, in the horizon *S P*, the ſtraight line *Af* would have cut *DS* in *k*; and *ik* would have been the top of the ſquare. But a child could tell, that *AikD* would be a monſtrous repreſentation of a ſquare in perſpective.

The angle of 60 degrees is only aſſumed here, as being the largeſt angle under which the eye can ſee an object diſtinctly; and not as a conſtant angle, under which all repreſentations in perſpective muſt be drawn. See § 10.

A Demonſtration of the above Rule (§ 12. and 13.) *for finding the true Point of Diſtance.*

14. In Fig. 1. of Plate II. let *AI* and *DK* be part of the two parallel ſides of a ſtraight avenue, divided into equal

ſquares, as *ABCD*, *BEFC*, *EGHF*, &c. and let trees be planted at the corners of each ſquare, as at *A*, *B*, *C*, *D*, *E*, *F*, *G*, *H*, *I*, and *K*.

Let *O* be the place of the obſerver, *S P* his horizon, and *S* the utmoſt point of his view, called the point of ſight; from which, the line *S O* is perpendicular to *SP* (ſee § 12.) To him, the two ſides of the avenue ſeem to come nearer and nearer to one another, as they are farther and farther from his eye, tending toward the point of ſight *S*, in the direction of the two ſtraight lines *AS* and *DS*. § 11.

In the parallel-ſided avenue, draw a ſtraight line *BO* from the tree *B* to the obſerver's eye at *O*; this line cuts the perſpective ſide *AS* of the avenue in the point *b*, which is the apparent place of the tree as ſeen by the obſerver. From the tree *C* draw the ſtraight line *CO* to the obſerver's eye at *O*, and that line will cut the perſpective ſide *DS* of the avenue in the point *c*, which is the apparent place of the tree as ſeen from *O*: then draw *bc* parallel to *AD*, and *AbcD* will be the true perſpective repreſentation of the ſquare *ABCD*.

In like manner, from the other trees *E*, *G*, *I*, and *F*, *H*, *K*, draw ſtraight lines to the obſerver's eye at *O*; and theſe lines will cut the perſpective ſides *AS* and *DS* of the avenue in the points *e*, *g*, *i*, and *f*, *h*, *k*; which are the apparent places of the trees, as ſeen by the obſerver. Laſtly, draw the lines *ef*, *gh*, *ik*, parallel to *AD*, and they will divide the perſpective view of the avenue ſo as to make it a juſt repreſentation thereof, with all its trees and ſquares, as ſeen from *O*.

Thus we find, the apparent places of the trees *B*, *E*, *G*, *I*, muſt demonſtratively be at *b*, *e*, *g*, *i*; and that the apparent places of the trees, *C*, *F*, *H*, *K*, muſt be at *c*, *f*, *h*, *k*, as ſeen from the point *O*:--the trees *A* and *D*, which are neareſt to the eye, appear in their true places.--Now we ſhall ſee, by placing the point of diſtance in the horizon *S P* according to the above-mentioned rule, whether we ſhall or ſhall not have apparent places of the trees in the ſame points as before; without drawing lines from their true places in the ſides of the avenue to the obſerver's eye at *O*.

Take *SP* equal to *SO*, and call *P* the point of diſtance. From *A* draw the ſtraight line *AP*, interſecting the perſpective ſide *DS* of the avenue in the point *c*, and to that point draw *b c* parallel to *AD*; and you have the firſt perſpective ſquare *AbcD* of the avenue, the very ſame as was found before, by the lines *BO* and *CO*.

From the point *b* draw *b P*, interſecting *DS* in the point *f*; and to that point draw *ef* parallel to *AD*, and you have the ſecond perſpective ſquare *b e f c*, the ſame as before.

From the point *e* draw *e P*, interſecting *DS* in the point *h*, and draw *gh* parallel to *AD*; then, *e g h f* will be the third perſpective ſquare of the avenue.

From the point *g* draw *g P*, interſecting *DS* in the point *k*, and draw *ik* parallel to *AD*, which finiſhes the fourth and laſt perſpective ſquare *g i k h* of the avenue.

In the ſame manner you may go on, drawing as many more perſpective ſquares up toward *S* as you pleaſe.

Now, as the ſtraight lines *AP*, *bP*, *e P*, and *g P*, (all drawn to the point of diſtance *P*) give the ſame points *b*, *e*, *g*, *i*, and *c*, *f*, *h*, *k*, for the apparent places of the trees as viewed from *O*, that the lines *BO*, *EO*, *GO*, *IO*, and *CO*, *FO*, *HO*, and *KO*, gave before, when drawn from the places of the trees themſelves; it is plain that we have put the point of diſtance *P* in the very point where it ought to be; that is, juſt as far from the point of ſight *S* as the obſerver's eye at *O* is from it.

And hence it is evident, that, ſuppoſing the eye to be at *O*, if the point of diſtance had been taken any where between *P* and *S* in the horizon *S P*, all the lines drawn from it into the perſpective avenue *AikD* would have gone above their true places, and would have given the points for the apparent places of the trees beyond thoſe in which the eye at *O* could ſee them; and would alſo have made all the perſpective ſquares in the avenue too broad.----On the contrary, if the point of diſtance had been taken any where beyond *P* from *S*, all the lines drawn from *that* point of diſtance would have gone below their true places in their perſpective avenue; and conſequently have brought the apparent places of the trees too near the obſerver's eye, and have made all the perſpective ſquares of the avenue narrower than they could really appear to the obſerver at *O*.

15. Hence it is manifeſt, that, when large objects are to be drawn in perſpective, the point of diſtance muſt be taken at leaſt as far from the point of ſight, as the obſerver could ſtand from the point of ſight when he ſees the ſide of the object next to him under an angle of 60 degrees. But in drawing agreeable perſpective views of ſmall objects, the obſerver ſhould be conſidered as viewing them under an angle not exceeding 30 degrees at moſt;

moſt: and ſuppoſing him to ſee them under that angle, take the diſtance of his place from the point of ſight in your compaſſes, and ſet off that extent from the point of ſight in the horizon, to find the point of diſtance therein.

OPERATION II.

To put a Square in Perſpective, as ſeen by a Perſon not ſtanding right againſt the Middle of either of its Sides, but rather nearly even with one of the Corners.

16. In Fig. 7. of Plate I. let *ABCD* be a true ſquare, viewed by an obſerver, not ſtanding at *o*, directly againſt the middle of its ſide *A D*, but at *O* almoſt even with its cor-

ner *D*, and viewing the ſide *AD* under the angle *AOD*; the angle *AoD* (under which he would have ſeen *A D* from *o*) being 60 degrees.

Make *AD* in Fig. 8. equal to *AD* in Fig. 7. and draw *SP* and *OO* parallel to *AD*. Then, in Fig. 8. let *O* be the place of the obſerver's eye, and *SO* be perpendicular to *SP* (as before, 12, 13.) then *S* ſhall be the point of ſight in the horizon *SP*.

Take *SO* in your compaſſes, and ſet that extent from *S* to *P*: then *P* ſhall be the true point of diſtance, taken according to the foregoing rules, § 12 and 13.

From *A* and *D* draw the ſtraight lines *A S* and *D S*: draw alſo the ſtraight line *AP*, interſecting *DS* in *C*.

Laſtly, to the point of interſection *C* draw *BC* parallel to *AD*; and *ABCD* in Fig. 8. will be a true perſpective repreſentation of the ſquare *ABCD* in Fig. 7. The point *M* is the center of each ſquare, and *AMC* and *BMD* are their diagonals.

OPERATION III.

To put a reticulated Square in Perſpective, as ſeen by a Perſon ſtanding oppoſite to the Middle of one of its Sides.

17. A reticulated ſquare is one that is divided into ſeveral little ſquares, like net-work, as Fig. 4. of Plate II. each ſide of which is divided into four equal parts, and the whole ſurface into four times four (or 16) equal ſquares.

Having divided this ſquare into the given number of leſſer ſquares, draw the two diagonals *A x C* and *B x D*.

Make *AD* in Fig. 5. equal to *AD* in Fig. 4. and divide it into four equal parts, as *A e*, *e g*, *g i*, and *i D*.

Draw *SP* for the horizon, parallel to *A D*, and, through the middle point *g* of *AD*, draw *O S* perpendicular to *AD* and *SP*.-Make *S* the point of ſight, and *O* the place of the obſerver's eye.

Take *SP* equal to *SO*, and *P* ſhall be the true point of diſtance.---Draw *AS* and *DS* to the point of ſight, and *A P* to the point of diſtance, interſecting *DS* in *C*: then draw *BC* parallel to *AD*, and the outlines of the reticulated ſquare *A B C D* will be finiſhed.

From the diviſion-points *e*, *g*, *i*, draw the ſtraight lines *ef*, *gh*, *ik*, tending toward the point of ſight *S*; and draw *BD* for one of the diagonals of the ſquare, the other diagonal *A C* being already drawn.

Through the points *r* and *s*, where theſe diagonals cut *e f* and *i k*, draw *lm* parallel to *AD*. Through the center-point *x*, where the diagonals cut *gh*, draw *n o* parallel to *AD*.--Laſtly, through the points *v* and *w*, where the diagonals cut *c f* and *i k*, draw *p q* parallel to *A D*; and the reticulated perſpective ſquare will be finiſhed.

This ſquare is truly repreſented, as if ſeen by an obſerver ſtanding at *O*, and having his eye above the horizontal plane *ABCD* on which it is drawn; as if *OS* was the height of his eye above that plane: and the lines which form the ſmall ſquares within it have the ſame letters of reference with thoſe in Fig. 4. which is drawn as it would appear to an eye placed perpendicularly above its center *x*.

OPERATION IV.

To put a Circle in Perſpective.

18. If a circle be viewed by an eye placed directly over its center, it appears perfectly round, as Fig. 2. but if it be obliquely viewed, it appears of an elliptical ſhape, as Fig. 3. This

is plain by looking at a common wine-glaſs ſet upright on a table.

19. Make a true reticulated ſquare, as Fig. 4. of Plate II. of the ſame diameter as you would have the circle; and ſetting one foot of your compaſſes in the center *x*, deſcribe as large a circle as the ſides of the ſquare will contain. Then, having put this reticulated ſquare into perſpective, as in Fig. 5. obſerve through what points of the croſs lines and diagonals of Fig. 4. the circle paſſes; and through the like points in Fig. 5. draw the ellipſis, which will be as true a perſpective repreſentation of the circle, as the ſquare in Fig. 5. is of the ſquare in Fig. 4.

OPERATION V.

To put a reticulated Square in perſpective, as ſeen by a Perſon not ſtanding right againſt the Middle of either of its Sides, but rather nearly even with one of its Corners.

20. In Fig. 6. of Plate II, let *O* be the place of an obſerver, viewing the ſquare *A B C D* almoſt even with its corner *D*.--Draw at pleaſure *S P* for the horizon, parallel to *A D*, and make *SO* perpendicular to *SP*: then, *S* ſhall be the point of ſight; and *P* the true point of diſtance, if *S P* be made equal to *SO*.

Draw *AS* and *DS* to the point of ſight, and *AP* to the point of diſtance,

inter-

interſecting *DS* in the point *C*; then draw *BC* parallel to *AD*, and the outlines of the perſpective ſquare will be finiſhed. This done, draw the lines which form the leſſer ſquares, as taught in *Oper*. III. and the work will be completed.----You may put a perſpective circle in this ſquare by the ſame rule as it was done in Fig. 5.

OPERATION VI.

To put a Cube in Perſpective, as if viewed by a Perſon ſtanding almoſt even with one of its Edges, and ſeeing three of its Sides.

21. In Fig. 7. of Plate II. let *AB* be the breadth of either of the ſix equal ſquare ſides of the cube *AG*; *O* the place of the obſerver, almoſt even

with the edge *CD* of the cube, *S* the point of ſight, *S P* the horizon parallel to *A D*, and *P* the point of diſtance taken as before.

Make *ABCD* a true ſquare; draw *BS* and *CS* to the point of ſight, and *BP* to the point of diſtance, interſecting *CS* in *G*.--Then draw *FG* parallel to *BC*, and the uppermoſt perſpective ſquare ſide *B F G C* of the cube will be finiſhed.

Draw *DS* to the point of ſight, and *AP* to the point of diſtance, interſecting *DS* in the point *I*: then draw *GI* parallel to *CD*; and, if the cube be an opaque one, as of wood or metal, all the outlines of it will be finiſhed; and then it may be ſhaded as in the figure.

But if you want a perſpective view of a tranſparent glaſs cube, all the ſides of which will be ſeen; draw *AH* towards the point of ſight, *FH* parallel to *BA*, and *HI* parallel to *AD*: then *AHID* will be the ſquare baſe of the cube, perſpectively parallel to the top *BFGC*; *ABFH* will be the ſquare ſide of the cube parallel to *CGID*, and *FGIH* will be the ſquare ſide parallel to *ABCD*.

As to the ſhading part of the work, it is ſuch mere childrens' play, in compariſon of drawing the lines which form the ſhape of any object, that no rules need be given for it. Let a perſon ſit with his left ſide toward a window, and he knows full well, that if any ſolid body be placed on a table before him, the light will fall on the left-hand ſide of the body, and the right-hand ſide will be in the ſhade.

OPERATION VII.

To put a ſquare Pavement in perſpective, conſiſting of any given ſquare Number of equal black and white Space pieces of Marble, and viewed by a Perſon ſtanding at a Diſtance from it, almoſt even with one of its Corners.*

22. In Fig. 1. of plate III. let *SP* be the horizon, *SO* perpendicular to *S P*, *O* the place of the obſerver, viewing the ſquare black and white marble pavement *ABCD*, nearly even with the corner *D*; *S* the point of ſight, *P*

---

* A *ſquare number* is the product of any given number multiplied by itſelf. Thus, 144 is the ſquare of 12; for 12 times 12 is 144; and 256 is the ſquare of 16.

the point of diſtance (§ 12.), and the ſide *AD* be parallel to *SP*.

Suppoſe the ſide *AD* (equal to the breadth of the pavement) to be 16 feet, and that each ſquare piece of marble in the pavement is a foot broad; then the whole pavement will contain 256 of theſe ſquare pieces; for 16 times 16 is 256; that is, 256 is the ſquare of 16.

Divide *AD* into 16 equal parts, as *Ab*, *bc*, *cd*, &c. and from theſe points of diviſion, *b*, *c*, *d*, &c. draw ſtraight lines to the point of ſight *S*.

From *P* the point of diſtance draw the ſtraight line *PD*, interſecting *AS* in the point *B*; then, from *B* draw *BC* parallel to *AD*, which will complete the outlines of the perſpective ſquare pavement *ABCD*.

Through the points where the diagonal *BD* interſects the lines drawn from *b*, *c*, *d*, *e*, &c. toward the point of ſight *S*, draw ſtraight lines parallel to *AD* (as in *Oper*. III. and V.) and you will have divided the ſquare pavement *ABCD* into 256 leſſer ſquares; one half of which may be ſhaded black, and the other half left white, to repreſent the 256 ſquare pieces of black and white marble which compoſe the pavement.

OPERATION VIII.

To put an oblong Square Pavement in Perſpective, whoſe Length is equal to any given Number of Times its Breadth.

23. In Fig. 1. of Plate III. ſuppoſe the given length *DF* or *AE* to be 32

feet, and the given breadth *AD* to be 16. We have already got half the given length *DC*, in the perſpective ſquare *ABCD*; and ſuch another added to it will complete the perſpective figure of the pavement.

To the right hand top-corner *C* of the ſquare *ABCD*, draw the ſtraight line *P C* from the point of diſtance *P*, interſecting *AS* at *E*: from the point *E* draw *EF* parallel to *A D*, and the outlines of the ſecond ſquare *B E F C* will be completed; which, as in the figure, may be divided into 256 leſſer ſquares, by the ſame method that *A BC D* was ſo divided: and then, in perſpective, the length of the oblong ſquare pavement *A E F D* will be twice as great as its breadth; and the whole will contain 512 leſſer ſquares.

24. If the given length be equal to three times the breadth, we muſt have a third perſpective ſquare *E G H F* joined to the top of the ſecond ſquare *B E F C*.

From the point of diſtance *P*, draw the ſtraight line *P F* to the right hand top-corner *F* of the ſecond ſquare, and interſecting *A S* at *G*: then, from the point *G* draw *G H* parallel to *AD*, which will complete the third perſpective ſquare *EGHF*----This ſquare (like the former two) may be ſubdivided into 256 leſſer ſquares; and then we ſhall have an oblong ſquare pavement *A G H D*, whoſe perſpective length is equal to three times its breadth, and divided into 768 leſſer ſquares.

25. And thus (as is plain by the figure) you may proceed, and make as many more perſpective ſquares (*GIKH*, *ILMK*, *LNOM*, &c.) as you pleaſe. --- There are ten ſuch ſquares in this figure; and if we ſuppoſe each of them to be 16 feet broad, and paved with black and white marble as *ABCD* is, the whole pavement, being ten times as long as it is broad will contain 2560 ſquare feet of marble ſurface.

OPERATION IX.

To put a Square Pyramid in Perſpective, as if ſtanding upright on its baſe, and viewed obliquely.

26. In Fig. 2. of plate III. let *AD* be the breadth of either of the four ſides

of the pyramid *ATCD* as its baſe *ABCD*; and *MT* its perpendicular height. Let *O* be the place of the obſerver, *S* his point of ſight, *SE* his horizon, parallel to *AD* and perpendicular to *OS*; and let the proper point of diſtance be taken in *SE* produced toward the left hand, as far from *S* as *O* is from *S*.

Draw *AS* and *DS* to the point of ſight, and *DL* to the point of diſtance, interſecting *AS* in the point *B*. Then, from *B*, draw *BC* parallel to *AD*; and *ABCD* ſhall be the perſpective ſquare baſe of the pyramid.

Draw the diagonal *AC*, interſecting the other diagonal *BD* at *M*, and this point of interſection ſhall be the center of the ſquare baſe.

Draw *MT* perpendicular to *AD*, and of a length equal to the intended height of the pyramid: then draw the ſtraight lines *AT*, *CT*, and *DT*; and the outlines of the pyramid (as viewed from *O*) will be finiſhed; which being done, the whole may be ſo ſhaded as to give it the appearance of a ſolid body.

If the obſerver had ſtood at *o*, he could have only ſeen the ſide *ATD* of the pyramid; and two is the greateſt number of ſides that he could ſee from any other place of the ground. But if he were at any height above the pyramid, and had his eye directly over its top, it would then appear like Fig. 3. and he would ſee all its four ſides *E*, *F*, *G*, *H*, with its top *t* juſt over the center of its ſquare baſe *ABCD*;

which would be a true geometrical, and not a perſpective ſquare.

OPERATION X.

To put two equal Squares in Perſpective, one of which ſhall be directly over the other, at any given Diſtance from it, and both of them parallel to the Plane of the Horizon.

27. In Fig. 4. of Plate III. let *ABCD* be a perſpective ſquare on a horizontal plane, drawn according to the foregoing rules (§ 16), *S* being the point of ſight, *SP* the horizon (parallel to *AD*), and *P* the point of diſtance.

Suppoſe *AD*, the breadth of this ſquare, to be three feet; and that it is required to place juſt ſuch another ſquare *EFGH* directly above it, parallel to it, and two feet from it.

Make *AE* and *DH* perpendicular to *AD*, and two thirds of its length: draw *E H*, which will be equal and parallel to *AD*; then draw *E S* and *HS* to the point of ſight *S*, and *EP* to the point of diſtance *P*, interſecting *H S* in the point *G*; this done, draw *F G* parallel to *E H*; and you will have two perſpective ſquares *ABCD* and *E F G H*, equal and parallel to one another, the latter directly above the former, and two feet diſtance from it; as was required.

By this method, ſhelves may be drawn, parallel to one another, at any diſtance from each other in proportion to their length.

OPERATION XI.

To put a Square Table in Perſpective ſtanding on four upright Square legs of any given Lenth with reſpect to the Breadth of the Table.

28 in Fig. 4. of Plate III. let *ABCD* be the ſquare part of the floor on which the table is to ſtand, and *E F G H* the ſurface of the ſquare table, parallel to the floor.

Suppoſe the table to be three feet in breadth, and its height from the floor to be two feet; then, two thirds of *AD* or *EH* will be the length of the legs *i* and *k*; the other two *(l* and *m)* being of the ſame length in perſpective.

Having drawn the two equal and parallel ſquares *A B CD* and *EFGH*, as ſhewn in *Oper.* X. let the legs be ſquare in form, and fixed into the table at a diſtance from its edges equal to their thickneſs. Take *A a* and *Dd* equal to the intended thickneſs of the legs, and *ab* and *dc* alſo equal thereunto. Draw the diagonals *A C* and *B D*, and draw ſtraight lines from the points *a*, *b*, *c*, *d*, toward the point of ſight *S*, and terminating at the ſide *B C*. Then through the points where theſe lines cut the diagonals, draw the ſtraight lines *n* and *o*, *p* and *q*, parallel to *A D*; and you will have formed four perſpective ſquares (like *A B C D* in Fig. 2.) for the baſes of the four legs of the table: and then it is eaſy to draw the four upright legs by parallel lines, all perpendicular to *A D*;

AD; and to ſhade them as in the figure.

To repreſent the intended thickneſs of the table-board, draw *eh* parallel to *EH*, and *HG* toward the point of ſight *S*: then ſhade the ſpaces between theſe lines, and the perſpective figure of the table will be finiſhed.

OPERATION XII.

To put an oblong Square Table in Perſpective, of any given Length with reſpect to its Breadth.

29. Suppoſe the given length to be four feet, and the breadth to be three. --In Fig. 6. of Plate II. let *AD* be the length, and divide it into four equal parts *Ae*, *eg*, *gi*, *iD*: draw *AS* and

DS to the point of ſight *S*; and *AP* to the point of diſtance *P*.

From the point *i*, which is three fourths of *AD*, draw *i s* toward the point of ſight, till it meets the diagonal *A C* in *s*: then, through that point of meeting, draw *lm* parallel to *AD*; and you will have an oblong ſquare *AlmD*, whoſe breadth *Al* or *D m* is perſpectively equal to three quarters of its length *A D*.

30. Let the breadth of the table be equal to half its length *AD*.---From *g*, the middle point between *A* and *D*, draw *g x* toward the point of ſight *S*, till it meets the diagonal *AC* in the point *x*; then, through the point *x*, draw *no* parallel to *AD*, and you will have an oblong ſquare *AnoD*, whoſe

length *A D* is equal to twice its breadth *An* or *Do*.

31. Suppoſe the length to be equal to four times the breadth.--From *e*, a fourth part of the diſtance between *A* and *D*, draw *ev* toward the point of ſight *S*, till it meets the diagonal *AC* at *v*; then, through that point of meeting, draw *pq* parallel to *AD*, and you will have an oblong ſquare *ApqD*, whoſe length *A D* is four times as great as its perſpective breadth *Ap* or *D q*.

In this manner you may make the breadth bear any proportion to the length that you pleaſe; and may put legs to the table as ſhewn in *Oper*. XI.

OPERATION XIII.

To put five Square Pyramids in Perſpective, ſtanding upright on a Square Pavement compoſed of the Surface of 81 *Cubes.*

32. In Fig. 1. of Plate IV. let *ABCD* be a perſpective ſquare drawn according to the foregoing rules; *S* the point of ſight, *P* the point of diſtance in the horizon *PS*, and *AC* and *BD* the two diagonals of the ſquare.

Divide the ſide *AD* into 9 equal parts (becauſe 9 times 9 are 81) as *Aa*, *ab*, *bc*, &c. and from theſe points of diviſion, *a*, *b*, *c*, *d*, &c. draw lines toward the point of ſight *S*, terminating at the furthermoſt ſide *B C* of the ſquare. Then, through the points where theſe lines cut the diagonals, draw ſtraight lines parallel to *AD* (as in *Oper.* III.), and the perſpective ſquare *ABCD* will be ſubdivided into 81 leſſer ſquares, repreſenting the upper ſurfaces of 81 cubes, laid cloſe to one another's ſides, in a ſquare form.

Draw *AK* and *DL*, each equal to *Aa*, and perpendicular to *AD*; and draw *LN* toward the point of ſight *S*: then draw *KL* parallel to *AD*, and its diſtance from *AD* will be equal to *Aa*.--This done, draw *al*, *bm*, *cn*, *do*, *ep*, *fq*, *gr*, and *hs*, all parallel to *AK*; and the ſpace *ADLK* will be ſubdivided into nine equal ſquares, which are the outer upright ſurfaces of the nine cubes in the ſide *AD* of the ſquare *ABCD*.

Draw *LN* toward the point of ſight *S*; and from the points where the lines, which are parallel to *A D* in this ſquare, meet the ſide *CD* thereof, draw ſhort lines to *LN*, all parallel to *D L*, and they will divide that ſide into the outer upright ſurfaces of the nine cubes which compoſe it: and then the outſides of all the cubes that can be viſible to an obſerver, placed at a proper diſtance from the corner *D* of the ſquare, will be finiſhed.

As taught in *Oper.* IX. place the pyramid *A E* upright on its ſquare baſe *A t v a*, making it as high as you pleaſe; and the pyramid *D H* on its ſquare baſe *h u w D*, of equal height with *A E*.

Draw *E H* from the top of one of theſe pyramids to the top of the other; and *E H* will be parallel to *A D*.

Draw *E S* and *H S* to the point of ſight *S*, and *H P* to the point of diſtance *P*, interſecting *ES* in *F*.

From the point *F*, draw *FG* parallel to *EH*; then draw *EG*, and you will have a perſpective ſquare *EFGH* (parallel to *ABCD*) with its two diagonals *EG* and *FH*, interſecting one another in the center of the ſquare at *I*. The four corners of this ſquare, *E*,*F*,*G*,*H*, give the perſpective heights of the four pyramids *AE*, *BF*, *CG*, and *DH*; and the interſection *I* of the diagonals gives the height of the pyramid *MI*, the center of whoſe baſe is the center of the perſpective ſquare *A B C D*.

Laſtly, place the three pyramids *BF*, *CG*, *MI*, upright on their reſpective baſes at *B*, *C*, and *M*; and the required perſpective repreſentation will be finiſhed, as in the figure.

OPERATION XIV.

To put upright Pyramids in Perſpective, on the Sides of an oblong Square or Parallelogram; ſo that their Diſtance from one another ſhall be equal to the Breadth of the Parallelogram.

In moſt of the foregoing operations, we have conſidered the obſerver to be ſo placed, as to have an oblique view of the perſpective objects: in this, we ſhall ſuppoſe him to have a direct view of Fig. 2. Plate IV. that is, ſtanding right againſt the middle of the end *A D* which is neareſt to his eye, and viewing *A D* under an angle of 60 degrees. § 10.

Having cut *AD* in the middle, by the perpendicular line *S s*, take *S* therein at pleaſure for the point of ſight, and draw *ES* for the horizon, parallel to *AD*.---Here *S s* muſt be ſuppoſed to be produced downward, below the limits of the plate, to the place of the obſerver; and *SE* to be produced towards the left hand beyond *E*, far enough to take a proper point of diſtance therein, according to the foregoing rules.

Take *Ad* at pleaſure, and *Dg* equal to *Ad*, for the breadths of the ſquare baſes of the two pyramids *A E* and *DF*

DF next the eye: then draw *AS* and *dS*, and likewiſe *DS* and *gS*, to the point of ſight *S*; and *D G* on to the point of diſtance, interſecting *A S* in *G*: then, from *G* draw *GI* parallel to *AD*, and you will have the firſt perſpective ſquare *AGID* of the parallelogram *ABCD*.

From *I* draw *IH* to (or toward) the point of diſtance, interſecting *A S* in *H*: then, from *H* draw *HK*, parallel to *AD*, and you will have the ſecond perſpective ſquare *GHKI* of the parallelogram.---Go on in this manner (which is the ſame with the method demonſtrated in *Oper*. I.) till you have drawn as many perſpective ſquares up toward *S* as you pleaſe.

Through the point *e*, where *DG* interſects *gS*, draw *bf* parallel to *AD*;

and you will have formed the two perſpective ſquare baſes *A b c d* and *e f D g* of the two pyramids at *A* and *D*.

From the point *f* (the upper outward corner of *e f D g*) draw *f h* toward the point of diſtance, till it meets *AS* in *h*; then, from this point of meeting, draw *h m* parallel to *G I*, and you will have formed the two perſpective ſquares *Ghik* and *lm In*, for the ſquare baſes of the two pyramids at *G* and *I*.

Proceed in the ſame manner to find the baſes of all the other pyramids, at the corners of the reſt of the perſpective ſquares in the parallelogram *A B C D*, as ſhewn by the figure.--- Then, Having placed the firſt two pyramids at *A* and *D* upright on their ſquare baſes, as ſhewn in *Oper.* IX. and made them of any equal heights at pleaſure, draw *E S* and *F S* from the tops of theſe pyramids to the point of ſight *S:* place all the reſt of the pyramids upright on their reſpective baſes, making their tops touch the ſtraight lines *ES* and *FS*; and all the work, except the ſhading part, will be finiſhed.

33. *Remark.*--It muſt be acknowledged, that there is ſomething in this figure not quite agreeable to the eye; which is, that the two pyramids at *G* and *I* ſeem to be too far from thoſe at *A* and *D*, when compared with the diſtances between the reſt.--But this ariſes from their being viewed

(in the figure) at a greater diſtance than the obſerver is ſuppoſed to be at from the point of ſight *S*; which is but 7 inches and three fourths of an inch, in viewing *AD* under an angle of 60 degrees: whereas, in viewing the figure, we ſeldom bring the paper within leſs than a foot from the eye. ---But, if a perſon who looks at the figure will place his eye directly over the point of ſight *S*, ſo that an imaginary line $7\frac{3}{4}$ inches long, from the point of ſight, and perpendicular to the ſurface of the paper, ſhall touch his eye; the diſagreeable idea will vaniſh, and the repreſentation will appear natural.

On which it may be proper to obſerve, that, when people look at perſpective drawings, they generally keep their eye at a greater diſtance than what would form an angle of 60 degrees with the boundaries of the object; and therefore they ſee it under an angle conſiderably leſs than 60 degrees. And, for this reaſon, it may be proper to inform the learner, that, in drawing perſpective repreſentations of objects, he had better put his ſuppoſed obſerver's ſtation ſo far from the ſide *AD* next his eye, that it may not ſubtend an angle of more than 45 degrees, or 50 at moſt: and then the drawings will have a much more agreeable appearance.

It is true, that this caution, though generally neceſſary, is attended in practice with a ſmall inconvenience: which is, that as the point of diſtance muſt always be placed as far from the point of ſight as the obſerver is ſuppoſed to be from it, the ſchemes, though but ſmall, muſt be drawn on large paper; otherwiſe the point of diſtance may fall without the limits of the paper; as it does even in this figure (Fig. 2.), on account of the breadth thereof from *A* to *D*, although it is drawn as if viewed under an angle of 60 degrees.--But this is of very little moment, as it is eaſy to fix a long ſlip of paper by two wafers to the edge of that on which any ſcheme is drawn; ſo that the horizon-line may be extended out on that ſlip, to find the point of diſtance therein, as far from the point of ſight as you pleaſe.

OPERATION XV.

To put a Rummer or Drinking-Glaſs in Perſpective.

34. According the the foregoing method (*Oper.* X.) draw the two equal and parallel perſpective ſquares *A B C D* and *EFGH* in Fig. 3. of Plate IV. the latter directly above the former. Then, as in *Oper.* IV. put a perſpective circle in the lowermoſt ſquare for the bottom of the cup, and one in the uppermoſt for the top or brim thereof, and draw out the reſt of the figure in whatever ſhape you pleaſe.

OPERATION XVI.

To put a Square Pyramid of equal ſized Cubes in Perſpective.

35. Fig. 2. of Plate V. repreſents a pyramid of this kind; conſiſting (as it were) of ſquare tables of cubes, one table above another; 81 in the loweſt, 49 in the next, 25 in the third, 9 in the fourth, and 1 in the fifth or uppermoſt. Theſe are the ſquare numbers of 9, 7, 5, 3, and 1.

If the artiſt is already maſter of all the preceding operations, he will find leſs difficulty in this than in attending to the following deſcription of it: for it cannot be deſcribed in a few words, but may be executed in a very ſhort time.

In Fig. 1. having drawn *PS* for the horizon, and taken *S* for the point of ſight therein (the obſerver being at *O*) draw *AD* parallel to *PS* for the ſide (next the eye) of the firſt or lowermoſt table of cubes. Draw *AS* and *D S* to the point of ſight *S*, and *D P* to the point of diſtance *P*, interſecting *AS* in the point *B*. Then, from *B*, draw *BC* parallel to *AD*, and you will have the ſurface *ABCD* of the firſt table.

Divide *A D* into nine equal parts, as *Aa*, *ab*, *bc*, *cd*, &c. then make *A K* and *DL* equal to *Aa*, and perpendicular to *AD*. Draw *KL* parallel to *AD*, and from the points of equal diviſion at *a*, *b*, *c*, &c. draw lines to *KL*, all parallel to *AK*. Then draw *b S* to the point of ſight *S*, and from the diviſion-points *a*, *b*, *c*, &c. draw lines with a black lead pencil, all tending toward the point of ſight, till they meet the diagonal *B D* of the ſquare.

From theſe points of meeting draw black lead lines to *DC*, all parallel to *AD*; then draw the parts of theſe lines with black ink which are marked 1, 2, 3, 4, &c. between *b E* and *D C*.

Having drawn the firſt of theſe lines *β q* with black ink, draw the parts *a i*, *bk*, *cl*, &c. (of the former lines which meet the diagonal *B D*) with black ink alſo; and rub out the reſt of the black lead lines, which would otherwiſe confuſe the following part of the work. Then, draw *LF* toward the point of ſight *S*; and, from the points where the lines 1, 2, 3, 4, &c. meet the line *DC*, draw lines down to *LF*, all parallel to *DL*; and all the viſible lines between the cubes in the firſt table will be finiſhed.

Make *i G* equal and perpendicular to β *i*, and *q M* equall and parallel to *iG*: then draw *GM*, which will be equal and parallel to *i q*. From the points *k*, *l*, *m*, *n*, &c. draw *k n*, *l o*, *mp*, &c. all parallel to *i G*, and the outſides of the ſeven cubes in the ſide *G q* of the ſecond table will be finiſhed.

Draw *GS* and *MS* to the point of ſight *S*, and *MP* to the point of diſtance *P*, interſecting *GS* in *H*; then, from the point of interſection *H*, draw *H I* parallel to *A D*; and you will have the ſurface *GHIM* of the ſecond table of cubes.

From the points *n*, *o*, *p*, *q*, &c. draw black lead lines toward the point of ſight *S*, till they meet the diagonal *MH* of the perſpective ſquare ſurface *GHIM*; and draw *s N*, with black ink, toward the point of ſight.

From thoſe points where the lines drawn from *n*, *o*, *p*, *q*, &c. meet the diagonal *MH*, draw black lead lines to *MI*, all parallel to *AD*; only draw the whole firſt line γ 1 with black ink, and the parts, 2, 3, 4, &c. and *nt*, *ou*, *pv*, &c. of the other lines between *y N* and *MI*, and *GM* and γ 1, with the ſame; and rub out all the reſt of the black lead lines, to avoid further confuſion. Then, from the points where the ſhort lines 1, 2, 3, &c. meet the line *MI*, draw lines down to *q E*, all parallel to *Mq*, and the outer ſurfaces of the ſeven cubes in the ſide *ME* will be finiſhed; and all theſe laſt lines will meet the former parallels 2, 3, 4, &c. in the line *q E*.

Make *t O* equal and perpendicular to *γ t*, and *y P* equal and parallel to *t O*; then draw *OP*, which will be equal and parallel to *ty*.--This done, draw *OS* and *PS* to the point of ſight *S*, and *PP* to the point of diſtance *P* in the horizon. Laſtly, from the point *Q*, where *P P* interſects *O S*, draw *QR* parallel to *OP*; and you will have the outlines *OQRP* of the ſurface of the third perſpective table of cubes.

From the points *u*, *v*, *w*, *x*, draw upright lines to *O P*, all parallel to *t O*, and you will have the outer ſurfaces of the five cubes in the ſide *Oy* of this third table.

From the points where theſe upright lines meet *OP*, draw lines toward the point of ſight *S*, till they meet the diagonal *PQ*; and from theſe points of meeting draw lines to *PR*, all parallel to *OP*, making the parts 2, 3, 4, 5, of theſe lines with black ink which lie between *ZY* and *PR*. Then, from the points where theſe lines meet *PR*, draw lines down to *y N*; which will bound the outer ſurfaces of the five cubes in the ſide *PN* of the third table.

Draw the line *δ* 1 with black ink; and, at a fourth part of its length between *δ* and *Z*, draw an upright line to *S*, equal in length to that fourth part, and another equal and parallel thereto from *Z* to *V*: then draw *SV* parallel to δ*Z*, and draw the two upright and equidiſtant lines between δ*Z* and *SV*, and you will have the outer ſurfaces of the three cubes in the ſide *SZ* of the fourth table.

Draw *SS* and *VS* to the point of ſight *S* in the horizon, and *VP* to the point of diſtance therein, interſecting *SS* in *T*; then draw *TU* parallel to *SV*, and you have *STUV*, the ſurface of the fourth table; which being reticulated or divided into 9 perſpective ſmall ſquares, and the uppermoſt cube *W* placed on the middlemoſt of the ſquares, all the outlines will be finiſhed; and when the whole is properly ſhaded, as in Fig. 2. the work will be done.

OPERA-

OPERATION XVII.

To repreſent a double Croſs in Perſpective.

36. In Fig. 3. of Plate V. let *ABCD* and *EFGH* be two perſpective ſquares, equal and parallel to one another, the uppermoſt directly above the lowermoſt, drawn by the rules laid down in *Oper.* X. and as far aſunder as is equal to the given height of the upright part of the croſs; *S* being the point of ſight, and *P* the point of diſtance, in the horizon *PS* taken parallel to *AD*.

Draw *AE*, *DH*, and *CG*; then, *AEHD* and *DHGC* ſhall be the two viſible ſides of the upright part of the croſs; of which, the length *AE* is here made equal to three times the breadth *E H*.

Divide *DH* into three equal parts, *HI*, *IK*, and *KD*. Through theſe points of diviſion, at *I* and *K*, draw *M O* and *P R* parallel to *AD*; and make the parts *MN*, *IO*, *PQ*, *KR*, each equal to *HI*: then draw *MP* and *O R* parallel to *D H*.

From *M* and *O*, draw *MS* and *OS* to the point of ſight *S*; and from the point of diſtance *P* draw *PN* cutting *MS* in *T*: from *T* draw *TU* parallel to *MO*, and meeting *OS* in *U*; and you will have the uppermoſt ſurface *MTUO* of one of the croſs pieces of the figure. ----From *R*, draw *RS* to the point of ſight *S*; and from *U*, draw *UV* parallel to *OR*; and *OUVR* ſhall be the perſpective ſquare end next the eye of that croſs-part.

Draw *PMx* (as long as you pleaſe) from the point of diſtance *P*, through the corner *M*; lay a ruler to *N* and *S*, and draw *XN* from the line *Px*:-then lay the ruler to *I* and *S*, and draw *YZS*.--Draw *XY* parallel to *MO*, and make *XW* and *YB* equal and perpendicular to *XY*: then draw *WB* parallel to *XY*, and *WXYB* ſhall be the ſquare viſible end of the other croſs-part of the figure.

Draw *BK* toward the point of ſight *S*; and from *U* draw *UP* to the point of diſtance *P*, interſecting *YS* in *Z*: then, from the interſection *Z*, draw *Za* parallel to *MO*, and *Zb* parallel to *HD*, and the whole delineation will be finiſhed.

This done, ſhade the whole, as in Fig. 4. and you will have a true perſpective repreſentation of a double croſs.

OPERATION XVIII.

To put three Rows of upright Square Objects in Perſpective, equal in Size, and at equal Diſtances from each other, on an oblong Square Plain, the Breadth of which ſhall be of any aſſigned Proportion to the Length thereof.

37. Fig. 2. of Plate VI. is a perſpective repreſentation of an oblong ſquare plain, three times as long as it is broad, having a row of nine upright ſquare objects on each ſide, and one of the ſame number in the middle; all equally high, and at equal diſtances from

one another, both long-wiſe and croſs-wiſe, on the ſame plane.

In Fig. 1. *PS* is the horizon, *S* the point of ſight, *P* the point of diſtance, and *AD* (parallel to *PS*) the breadth of the plain.

Draw *AS*, *NS*, and *DS*, to the point of ſight *S*; the point *N* being in the middle of the line *AD*: and draw *DP* to the point of diſtance *P*, interſecting *AS* in the point *B*: then, from *B* draw *BC* parallel to *AD*, and you have the perſpective ſquare *ABCD*.

Through the point *i*, where *DB* interſects *NS*, draw *ae* parallel to *AD*; and you will have ſubdivided the perſpective ſquare *ABCD* into four leſſer ſquares as *AaiN*, *NieD*, *aBki*, and *i k C e*.

From the point *C* (at the top of the perſpective ſquare *ABCD*) draw *CP* to the point of diſtance *P*, interſecting *A S* in *E*; then, from the point *E* draw *E F* parallel to *A D*; and you will have the ſecond perſpective ſquare *B E F C*.

Through the point *l*, where *CE* interſects *N S*, draw *bf* parallel to *A D*; and you will have ſubdivided the ſquare *B E F C* into the four ſquares *B b l k*, *k l f C*, *b E m l*, and *l m F f*.

From the point *F* (at the top of the perſpective ſquare *BEFG*) draw *FP* to the point of diſtance *P*, interſecting *AS* in *I*; then, from the point *I* draw

IK parallel to *AD*; and you will have the third perſpective ſquare *EIKF*.

Through the point *n*, where *FI* interſects *NS*, draw *c g* parallel to *AD*; and you will have ſubdivided the ſquare *EIKF* into four leſſer ſquares, *Ecnm*, *mngF*, *cIon*, and *noKg*.

From the point *K* (at the top of the third perſpective ſquare *EIKF*) draw *KP* to the point of diſtance *P*, interſecting *AS* in *L*; then, from the point *L* draw *LM* parallel to *AD*, and you will have the fourth perſpective ſquare *I L M K*.

Through the point *p*, where *K L* interſects *NS*, draw *dh* parallel to *AD*; and you will have ſubdivided the ſquare *I L M K* into the four leſſer ſquares *I d p o*, *o p h K*, *d L q p*, and *p q M h*.

Thus, we have formed an oblong ſquare *A L M D*, whoſe perſpective length is equal to four times its breadth, and it contains 16 equal perſpective ſquares.---If greater length was ſtill wanted, we might proceed further on toward *S*.

Take *A* 3 equal to the intended breadth of the ſide of the upright ſquare object *A Q* (all the other ſides being of the ſame breadth) and *AO* for the intended height. Draw *O* 18 parallel to *AD*, and make *D*8 and 4 7 equal to *A* 3; then draw 3 *S*, 4 *S*, 7 *S*, and 8 *S* to the point of ſight *S*; and among them we ſhall have the perſpective ſquare baſes of all the 27 upright objects on the plain.

Through the point 9, where *DB* interſects 8 *S*, draw 1 10 parallel to *AD*, and you have the three perſpective ſquare baſes *A* 1 2 3, 4 5 6 7, 8 9 10 *D* of the three upright ſquare objects at *A*, *N*, and *D*.

Through the point 21, where *e b* interſects 8 *S*, draw 14 11 parallel to *AD*; and you will have the three perſpective ſquares *a* 14 15 16, 17 18 19 20, and 21 11 *e* 22, for the baſes of the ſecond croſs row of objects; namely, the next beyond the firſt three at *A*, *N*, and *D*.

Through the point *w*, where *C E* interſects 8 *S*, draw a line parallel to *BC*; and you will have three perſpective ſquares, at *B*, *k*, and *C*, for the baſes of the third row of objects; one of which is ſet up at *B*.

Through the point *x*, where *fc* interſects 8*S*, draw a line parallel to *b f*; and you will have three perſpective ſquares, at *b*, *l*, and *x*, for the baſes of the fourth croſs row of objects.

Go on in this manner, as you ſee in the figure, to find the reſt of the ſquare baſes, up to *LM*; and you will have 27 upon the whole oblong ſquare plane, on which you are to place the like number of objects, as in Fig. 2.

Having aſſumed *A O* for the perſpective height of the three objects (at *A*, *N*, and *D*) next the obſerver's eye, and drawn *O* 18 parallel to *AD*, in order to make the objects at *N* and *D* of the ſame height as that at *O*; and having drawn the upright lines 4 15, 7 *W*, 8 *X*, and *D* 22, for the heights *N* and *D*; draw *O S* and *R S*, 15*S* and *WS*, *XS* and 22 *S*, all to the point of ſight *S*; and theſe lines will determine the perſpectively equal heights of all the reſt of the upright objects, as ſhewn by the two placed at *a* and *B*.

To draw the ſquare tops of theſe objects, equal and parallel to their baſes, we need only give one example, which will ſerve for all.

Draw 3 *R* and 2 *Q* parallel to *AO*, and up to the line *R S*; then draw *PQ* parallel to *OR*, and *OPQR* ſhall be the top of the object at *A*, equal and parallel to its ſquare baſe *A* 1 2 3. -----In the ſame eaſy way the tops of all the other objects are formed.

When all the reſt of the objects are delineated, ſhade them properly, and the whole perſpective ſcheme will have the appearance of Fig. 2.

OPERATION XIX.

To put a Square Box in Perſpective, containing a given Number of leſſer Square Boxes, of a Depth equal to their Width.

38. Let the given number of little ſquare boxes or cells be 16, then 4 of them make the length of each ſide of the four outer ſides *ab*, *bc*, *cd*, *da*, as in Fig. 3. and the depth *af* is equal to the width *ae*.--Whoever can draw the reticulated ſquare in *Oper*. V. (Fig. 6. of Plate II.) will be at no loſs about putting this perſpective ſcheme in practice.

OPERA-

OPERATION XX.

To put Stairs, with equal and parallel Steps, in Perſpective.

39. In Fig. 1. of Plate VII. let *ab* be the given breadth of each ſtep, and *ai* the height thereof.--Make *b c*, *c d*, *de*, &c. each equal to *a b*; and draw all the upright lines *a i*, *b l*, *c n*, *d p*, &c. perpendicular to *a b* (to which the horizon *s S* is parallel) and from the points *i*, *l*, *n*, *p*, *r*, &c. draw the equidiſtant lines *iB*, *lC*, *n D*, &c. parallel to *a b*; theſe diſtances being equal to that of *iB* from *a b*.

Draw *x i*, touching all the corner-points *l*, *n p*, *r*, *t*, *v*; and draw 2 16 parallel to *x i*, as far from it as you want the length of the ſteps to be.

Toward the point of ſight *S*, draw the lines *a* 1, *i* 2, *k* 3, *l* 4, &c. and draw 16 15, 14 13, 12 11, 10 9, 8 7, 6 5, 4 3, and 2 1, all parallel to *A h*, and meeting the lines *w* 15, *u* 13, *s* 11, &c. in the points 15, 13, 11, 9, 7, 5, 3, and 1: then, from theſe points draw 15 14, 13 12, 11 10, 9 8, 7 6, 5 4, and 3 2, all parallel to *h a*; and the outlines of the ſteps will be finiſhed. From the point 16, draw 16 *A* parallel to *h a*, and *A x* 16 will be part of the flat at the top of the uppermoſt ſtep.--This done, ſhade the work, as in Fig. 2. and the whole will be finiſhed.

OPERA-

OPERATION XXI.

To put Stairs with Flats and Openings in Perſpective, ſtanding on a horizontal Pavement of Squares.

40. In Fig. 3. of Plate VII. having made *S* the point of ſight, and drawn a reticulated pavement *A B*, as directed in *Oper*. III. and done it only with black lead lines, becauſe many of them muſt be rubbed out again; at any diſtance from the ſide *A B* of the pavement which is neareſt to the eye, and at any point where you chuſe to begin the ſtair at that diſtance, as *a*, draw *G a* parallel to *BA*, and take *a b* at pleaſure for the height of each ſtep.

Take *ab* in your compaſſes, and ſet that extent as many times upward from *F* to *E* as is equal to the firſt required number of ſteps *O*, *N*, *M*, *L*, *K*; and, from theſe points of diviſion in *E F*, draw 1*b*, 2*d*, 3*f*, 4*h*, and *E k*, all equidiſtant from one another, and parallel to *Fa*: then draw the equidiſtant upright lines *a b*, *t d*, *u f*, *v h*, *wk*, and *Im*, all perpendicular to *Fa*: then draw *m b*, touching the outer corners of theſe ſteps at *m*, *k*, *h*, *f*, *d*, and *b*; and draw *n s* parallel to *m b*, as far from it as you want the length of the ſteps *K*, *L*, *M*, *N*, *O* to be.

Toward the point of ſight, *S*, draw *m n*, *l* 5, *ko*, *i*6, *hp*, *f* 2, *d r*, and *b s*. Then (parallel to the bottom-line *BA*) through the points *n*, *o*, *p*, *q*, *r*, *s*, draw *n*8, 5 14, 6 15, 7 16, 1 17, and 2 *s*;

which done, draw *n* 5 and *o* 6 parallel to *l m*, and the outlines of the ſteps *K*, *L*, *M*, *N*, *O* will be finiſhed.

At equal diſtances with that between the lines marked 8 and 14, draw the parallel lines above, marked 9 10 11 12 and 13; and draw perpendicular lines upward from the points *n*, *o*, *p*, *q*, *r*, *s*, as in the figure.

Make *H m* equal to the intended breadth of the flat above the ſquare opening at the left hand, and draw *HW* toward the point of ſight *S*, equal to the intended length of the flat; then draw *W P* parallel to *Hm*, and the outlines of the flat will be finiſhed.

Take the width of the opening at pleaſure, as from *F* to *C*, and draw

CD equal and parallel to *FE*.--Draw *GH* parallel to *CD*, and the ſhort lines marked 33, 34, &c. juſt even with the parallel lines 1, 2, &c. From the points where theſe ſhort lines meet *CD*, draw lines toward the point of ſight *S* till they meet *D E*. Then, from the points where the lines 38, 39, 40, &c. of the pavement meet *Cy*, draw upright lines parallel to *C D*; and the lines which form the opening will be finiſhed.

The ſteps *P*, *Q*, *R*, *S*, *T*, and the flat *U* above the arch *V*, are done in the ſame manner with thoſe in Fig. 1. as taught in *Oper.* XX. and the equidiſtant parallel lines marked 18, 19, &c. are directly even with thoſe on the left-hand ſide of the arch *V*, and the upright lines on the right-hand ſide are equidiſtant with thoſe on the left.

From the points where the lines 18, 19, 20, &c. meet the right-hand ſide of the arch, draw lines toward the point of ſight *S*: and from the points where the pavement-lines 29, 30, 31, 32 meet the line drawn from *A* toward the point of ſight, draw upright lines toward the top of the arch.

Having done the top of the arch, as in the figure, and the few ſteps to the right-hand thereof; ſhade the whole, as in Fig. 4. and the work will be finiſhed.

And it is my opinion, that if the young artiſt is maſter of all the preceding operations, he will underſtand theſe two figures better by a bare view, than by any deſcription that can be given of them.

OPERATION XXII.

To put upright conical Objects in Perſpective, as if ſtanding on the Sides of an oblong Square at Diſtances from one another equal to the Breadth of the Oblong.

41. In Fig. 1. of Plate VIII. the baſes of the upright cones are perſpective circles inſcribed in ſquares of the ſame diameter, as ſhewn in *Oper.* IV. and the cones are ſet upright on their baſes by the ſame rules as are given in *Oper.* IX. and XIV. for pyramids, which we need not repeat here.

In the foregoing operations, we have conſidered the obſerver's eye to be above the level of the tops of all the objects, as if he viewed thoſe in Pl. IV. V. VI. and VII. when ſtanding on high ground. In the three figures on Plate VIII. we ſhall ſuppoſe him to be ſtanding on low ground, and the tops of the objects to be above the level of his eye.

In Fig. 1. let *AD* be the perſpective breadth of the oblong ſquare *ABCD*; and let *Aa* and *Dd* (equal to *Aa*) be taken for the diameters of the circular baſes of the two cones next the eye, whoſe intended equal heights ſhall be *AE* and *DF*.

Having made *S* the point of ſight, in the horizon parallel to *AD*, and found the proper point of diſtance therein, draw *AS* and *aS*, to contain the baſes of the cones on the left-hand ſide, and *DS* and *dS* for thoſe on the right.

Having made the two firſt cones at *A* and *D* of equal height at pleaſure, draw *E S* and *F S* from their tops to the point of ſight, for limiting the perſpective heights of all the reſt of the cones. Then, according to the directions in *Oper*. XIV. divide the parallelogram *A B C D* into as many equal perſpective ſquares as you pleaſe; find the baſes of the cones at the corners of the ſquares, and make the cones thereon, as in the figure.

If you would repreſent a cieling, equal and parallel to *A B C D*, ſupported on the tops of theſe cones, draw *EF*; then, *EFGH* ſhall be the cieling, and by drawing *ef* parallel to *E F*, you will have the thickneſs of the floor-boards and beams, which may be what you pleaſe.

This ſhews how any number of equidiſtant pillars may be drawn of equal heights, to ſupport the cieling of a long room; and how the walls of ſuch a room may be repreſented in perſpective at the backs of theſe pillars. It alſo ſhews how a ſtreet of houſes may be drawn in perſpective.

OPERATION XXIII.

To put a Square Hollow in Perſpective, the Depth of which ſhall bear any aſſigned proportion to its Width.

42. Fig. 2. of Plate VIII. is the repreſentation of a ſquare hollow, of which the depth *GA* is equal to three times its width *AD*; and *S* is the point of ſight, over which the obſerver's eye is ſuppoſed to be placed, looking perpendicularly down into it, but not directly over the middle.

Draw *AS* and *DS* to the point of ſight *S*; make *ST* the horizon, parallel to *AD*, and produce it to ſuch a length beyond *T* that you may find a point of diſtance therein not nearer *S* than if *AD* was ſeen under an angle of 60 degrees.

Draw *DU* to the point of diſtance, interſecting *AS* in *B*: then, from the point *B* draw *BC* parallel to *AD*; and you will have the firſt perſpective ſquare *ABCD*, equal to a third part of the intended depth.

Draw *CV* to the point of diſtance, interſecting *AS* in *E*: then, from the point *E* draw *E F* parallel to *A D*; and you will have the ſecond perſpective ſquare *BEFC*; which, added to the former one, makes two-thirds of the intended depth.

Draw *FW* to the point of diſtance, interſecting *AS* in *G*: then, from the point *G* draw *G H* parallel to *A D*;

and you will have the third perſpective ſquare *EGHF*; which, with the former two, makes the whole depth *A G H D* three times as great as the width *AD*, in a perſpective view.

Divide *A D* into any number of equal parts, as ſuppoſe 8; and from the diviſion-points *a*, *b*, *c*, *d*, *&c.* draw lines toward the point of ſight *S*, and ending at *G H*. Then, through the points where the diagonals *BD*, *EC*, *G F* cut theſe lines, draw lines parallel to *A D*; and you will have the parallelogram *AGHD* reticulated or divided into 192 ſmall and equal perſpective ſquares.

Make *AI* and *DM* equal and perpendicular to *AD*: then draw *IM*, which will be equal and parallel to *A D*;

AD; and draw *IS* and *MS* to the point of ſight *S*.

Divide *AI*, *IM*, and *MD* into the ſame number of equal parts as *AD* is divided: and from the points of diviſion draw lines toward the point of ſight *S*, ending reſpectively at *GK*, *KL*, and *LH*.

From thoſe points where the lines parallel to *AD* meet *AG* and *DH*, draw upright lines parallel to *AI* and *DM*; and from the points where theſe lines meet *IK* and *LM*, draw lines parallel to *IM*: then ſhade the work, as in the figure.

2

OPERATION XXIV.

To repreſent a ſemicircular Arch in Perſpective, as if it were ſtanding on two upright Walls, equal in Height to the Height of the Obſerver's Eye.

43. After having gone through the preceding operation, this will be more eaſy by a bare view of Fig. 3. in Plate VIII. than it could be made by any deſcription; the method being ſo much like that of drawing and ſhading the ſquare hollow.---We need only mention, that *a T b E A* and *D F c t d* are the upright walls on which the ſemicircular arch is built; that *S* is the point of ſight in the horizon *T t*, taken in the center of the arch; that *d* (in Fig. 2.) is the point

of diſtance; and that the two perſpective ſquares *ABCD* and *DEFC* make the parallelogram *A E F D* of a length equal to twice its breadth *A D*.

OPERATION XXV.

To repreſent a Square in Perſpective, as viewed by an Obſerver ſtanding directly even with one of its Corners.

44. In Fig. 1. of Plate IX. let *A*9*BC* be a true ſquare, viewed by an obſerver ſtanding at ſome diſtance from the corner *C*, and juſt even with the diagonal *C* 9.

Let *p S P* be the horizon, parallel to the diagonal *AB*; and *S* the point of ſight, even with the diagonal *C* 9.

Here it will be proper to have two points of diſtance *p* and *P*, equidiſtant from the point of ſight *S*.

Draw the ſtraight line 1 17 parallel to *AB*, and draw *A* 8 and *B* 10 parallel to *CS*. Take the diſtance between 8 and 9 in your compaſſes, and ſet it off all the way in equal parts from 8 to 1, and from 10 to 17.--The line 1 17 ſhould be produced a good way further both to right and left hand from 9, and divided all the way in the ſame manner.

From the points of equal diviſion, 8, 9, 10, &c. draw lines to the point of ſight *S*, and alſo to the two points of diſtance *p* and *P*, as in the figure.

Now it is plain, that *a c b* 9 is the perſpective repreſentation of *A* 9 *BC*, viewed by an obſerver even with the corner *C* and diagonal *C* 9.---But if there are other ſuch ſquares lying even with this, and having the ſame poſition with reſpect to the line 1 17, it is evident that the obſerver, who ſtands directly even with the corner *C* of the firſt ſquare, will not be even with the like corners *G* and *K* of the others; but will have an oblique view of them, over the ſides *FG* and *IK* which are neareſt his eye: and their perſpective repreſentations will be *egf* 6 and *hki* 3, drawn among the lines in the figure: of which, the ſpaces taken up by each ſide lie between three of the lines drawn toward the point of diſtance *p*, and three drawn to the other point of diſtance *P*.

OPERATION XXVI.

To repreſent a common Chair, in an oblique View, in Perſpective.

45. The original lines to the point of ſight *S*, and points of diſtance *p* and *P*, being drawn as in the preceding operation, chuſe any part of the plane, as *l m n* 13, on which you would have the chair *L* to ſtand.--- There are juſt as many lines (namely two) between *l* and *m* or 13. and *n*, drawn toward the point of diſtance *p*, at the left hand, as between *l* and 13, or *m* and *n*, drawn to the point of diſtance *P* on the right: ſo that *l m*, *mn*, *n*13, and 13*l*, form a perſpective ſquare.

From the four corners *l*, *m*, *n*, 13 of this ſquare raiſe the four legs of the chair to the perſpective perpendicular height you would have them: then make the ſeat of the chair a ſquare equal and parallel to *lmn* 13, as taught in *Oper*. X. which will make the two ſides of the ſeat in the direction of the lines drawn toward the point of diſtance *p*, and the fore and back part of the ſeat in direction of the lines drawn to the other point of diſtance *P*. This done, draw the back of the chair leaning a little backward, and the croſs bars therein tending toward the point of diſtance *P*. Then ſhade the work as in the figure; and the perſpective chair will be finiſhed.

OPERATION XXVII.

To repreſent an oblong Square Table in an oblique perſpective View.

46. In Fig. 1. of Plate IX. *M* is an oblong ſquare table, as ſeen by an obſerver ſtanding directly even with *C* 9 (ſee *Oper.* XXV.), the ſide next the eye being perſpectively parallel to the ſide *ac* of the ſquare *acb*9.--The forementioned lines drawn from the line 1 17 to the two points of diſtance *p* and *P*, form equal perſpective ſquares on the ground plane.

Chooſe any part of this plane of ſquares for the feet of the table to ſtand upon; as at *p*, *q*, *r*, and *s*, in direction of the lines *o p* and *r s* for the two long ſides, and *t s* and *q r* for the two ends; and you will have the oblong ſquare or parallelogram *q r s t* for the part of the floor or ground-plane whereon the table is to ſtand: and the breadth of this plane is here taken in proportion to the length as 6 to 10; ſo that, if the length of the table be ten feet, its breadth will be ſix.

On the four little perſpective ſquares at *q*, *r*, *s*, and *t*, place the four upright legs of the table, of what height you pleaſe, ſo that the height of the two next the eye, at *o* and *p* ſhall be terminated by a ſtraight line *u v* drawn to the point of diſtance *P*. This done, make the leaf *M* of the table an oblong ſquare, perſpectively equal and parallel to the oblong ſquare *q r s t* on which the feet of the table ſtands. Then ſhade the whole, as in the figure, and the work will be finiſhed.

If the line 1 17 was prolonged to the right and left hand, and equally divided throughout (as it is from 1 to 17), and if the lines which are drawn from *p* and *P* to the right and left hand ſides of the plate were prolonged till they came to the extended line 1 17, they would meet it in the equal points of diviſion. In forming large plans of this ſort, the ends of ſlips of paper may be paſted to the right and left edges of the ſheet on which the plan is to be formed.

CHAP.

CHAP. III.

The Deſcription of a Machine, by which any Perſon may delineate the true Perſpective Figures of Objects, without having learned any of the preceding Rules.

47. FIG. 2. of Plate IX. is a plane of this machine, and Fig. 3. is a repreſentation of it when made uſe of in drawing diſtant objects in perſpective. A ſketch of it was given me ſeveral years ago by the late ingenious Dr. BEVIS, who then told me he had never ſeen one of the like conſtruction: and as all thoſe to whom I have had the opportunity of ſhewing

it, have told me that they never ſaw nor heard of ſuch a one before, I have great reaſon to believe that the doctor was the inventor of it, although he never made it public.

In order that it may be the eaſier underſtood, I have put the letters of reference to the plane (Fig. 2.) in ſmall Italics, and the ſame letters to the like parts of it in the perſpective view (Fig. 3.) in Roman capitals; that the reader may look at them both, as he goes on with the following deſcription.

In Fig. 2. *abef* is an oblong ſquare board, repreſented by *A B E F* in Fig. 3. *x* and *y* (*X* and *Y*) are two hinges on which the part *cld* (*CLD*) is moveable. This part conſiſts of two arches or portions of circles *c m l* (*CML*) and *dnl* (*DNL*) joined together at the top *l* (*L*) and at bottom to the croſs bar *d c* (*DC*) to which one part of each hinge is fixed, and the other part to a flat board, half the length of the board *a b e f* (*ABEF*) and glued to its uppermoſt ſide. The center of the arch *cml* is at *d*, and the center of the arch *d n l* is at *c*.

On the outer ſide of the arch *dnl* is a ſliding piece *n* (much like the nut of the quadrant of altitude belonging to a common globe) which may be moved to any part of the arch between *d* and *l*: and there is ſuch another ſlider *o* on the arch *c l m*, which may be ſet to any part between *c* and *l*.-- A thread *cpn* (*CPN*) is ſtretched tight from the center *c* (*C*) to the ſlider *n* (*N*), *(N)*, and ſuch another thread is ſtretched from the center *d (D)* to the ſlider *o (O)*; the ends of the threads being faſtened to theſe centers and ſliders.

Now it is plain, that, by moving theſe ſliders on their reſpective arches, the interſection *p (P)* of the threads may be brought to any point of the open ſpace within the arches.--In the groove *k (K)* is a ſtraight ſliding bar *i (I)* which may be drawn further out, or puſhed further in, at pleaſure.

To the outer end of this bar *I* (Fig. 3.) is fixed the upright piece *H Z*, in which is a groove for receiving the ſliding piece *Q*. In this ſlider is a ſmall hole *r* for the eye to look through, in uſing the machine: and there is a long ſlit in *HZ*, to let the hole *r* be ſeen through when the eye is placed behind it, at any height of the hole above the level of the bar *I*.

How to delineate the Perſpective Figure of any diſtant Object (or Objects) by means of this Machine.

48. Suppoſe you wanted to delineate a perſpective repreſentation of the houſe *q s r p* (which we muſt imagine to be a great way off, without the limits of the plate) place the machine on a ſteady table, with the end *EF* of the horizontal board *ABEF* toward the houſe, ſo that, when the Gothic-like arch *D L C* is ſet upright, the middle part of the open ſpace (about *P*) within it may be even with the houſe when you place your eye at *Z*

and look at the houſe through the ſmall hole *r*. Then fix the corners of a ſquare piece of paper with four wafers on the ſurface of that half of the horizontal board which is neareſt the houſe; and all is ready for drawing.

Set the arch upright, as in the figure; which it will be when it comes to the perpendicular ſide *t* of the upright piece *s t* fixed to the horizontal board behind *D*. Then place your eye at *Z*, and look through the hole *r* at any point of the houſe, as *q*, and move the ſliders *N* and *O* till you bring the interſection of the threads at *P* directly between your eye and the point *q*: then put down the arch flat upon the paper on the board, as at *ST*, and the interſection of the threads will be at *W*. Mark the point *W* on the paper with the dot of a black lead pencil, and ſet the arch upright again, as before: then look through the hole *r*, and move the ſliders *N* and *O* till the interſection of the threads comes between your eye and any other point of the houſe, as *p*: then put down the arch again to the paper, and make a pencil-mark thereon at the interſection of the threads, and draw a line from that mark to the former one at *W*; which line will be a true perſpective repreſentation of the corner *pq* of the houſe.

Proceed in the ſame manner, by bringing the interſection of the threads ſucceſſively between your eye and other points of the outlines of the houſe, as *r*, *s*, &c. and put down the arch to mark the like points on the paper, at the interſection of the threads: then connect theſe points by ſtraight lines, which will be the perſpective outlines of the houſe. In like manner find points for the corners of the door and windows, top of the houſe, chimnies, &c. and draw the finiſhing lines from point to point: then ſhade the whole, making the lights and ſhades as you ſee them on the houſe itſelf, and you will have a true perſpective figure of it.--Great care muſt be taken, during the whole time, that the poſition of the machine be not ſhifted on the table; and to prevent ſuch an inconvenience, the table ſhould be very ſtrong and ſteady, and the machine fixed to it, either by ſcrews or clamps.

In the ſame way, a landſcape, or any number of objects within the field of view through the arch, may be delineated, by finding a ſufficient number of perſpective points on the paper, and connecting them by ſtraight or curved lines as they appear to the eye. And as this makes every thing in perſpective equally eaſy, without taking the trouble to learn any of the rules for drawing, the operations muſt be very pleaſing and agreeable. Yet, as ſcience is ſtill more ſo, we would by all means recommend it to our Readers to learn the rules for drawing particular objects; and to draw landſcapes by the eye, for which, I believe, no perſpective rules can be given. And although any thing may be very truly drawn in perſpective by means of this machine, it cannot be ſaid that there is the leaſt degree of ſcience in going *that* way to work.

The arch ought to be at leaſt a foot wide at bottom, that the eye at *Z* may have a large field of view through it; and the eye ſhould then be, at leaſt, $10\frac{1}{2}$ inches from the interſection of the threads at *P* when the arch is ſet upright. For, if it be nearer, the boundaries of view at the ſides near the foot of the arch will ſubtend an angle at *Z* of more than 60 degrees, which will not only ſtrain the eye (§ 10.), but will alſo cauſe the outermoſt parts of the drawing to have a diſagreeable appearance.---To avoid this, it will be proper to draw back the ſliding bar *I*, till *Z* be $14\frac{1}{2}$ inches diſtant from *P*; and then the whole field of view, through the foot wide arch, will not ſubtend an angle to the eye at *Z* of more than 45 degrees; which will give a more eaſy and pleaſant view, not only of all the objects themſelves, but alſo of their repreſentations on the paper whereon they are delineated. So that, whatever the width of the arch be, the diſtance of the eye from it ſhould be in this proportion: As 12 is to the width of the arch, ſo is 14½ to the diſtance of the eye (at *Z*) from it.

If a pane of glaſs, laid over with gum water, be fixed into the arch, and ſet upright when dry, a perſon who looks through the hole *r* may delineate the objects upon the glaſs which he ſees at a diſtance through and beyond it, and then transfer the delineation to a paper put upon the glaſs, as mentioned in §1.

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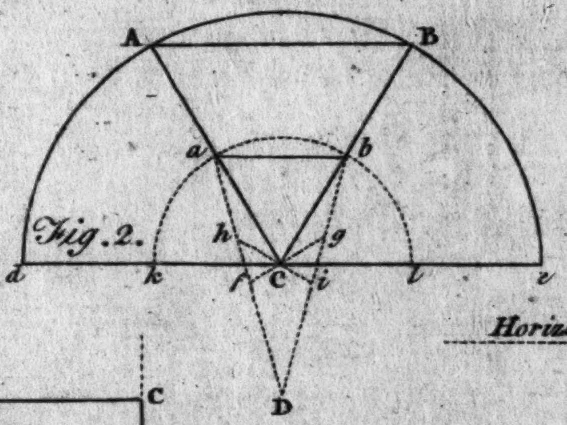
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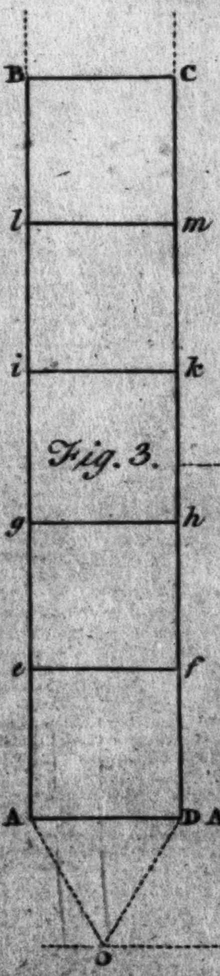
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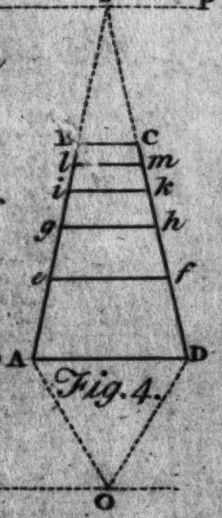
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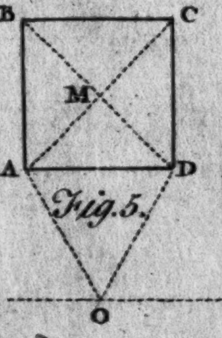
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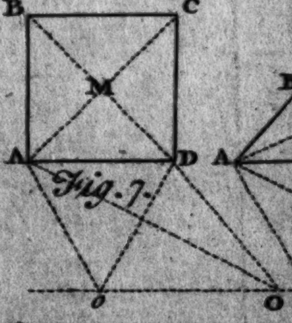
Fig. 7.

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PLATE.I.

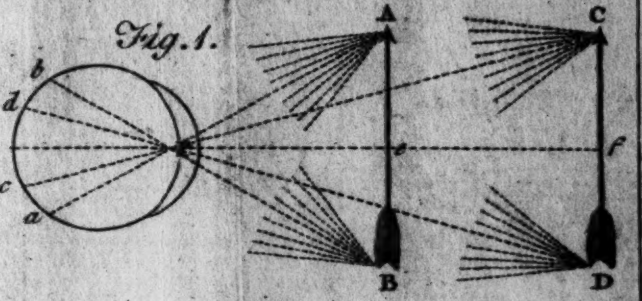
Fig. 1.
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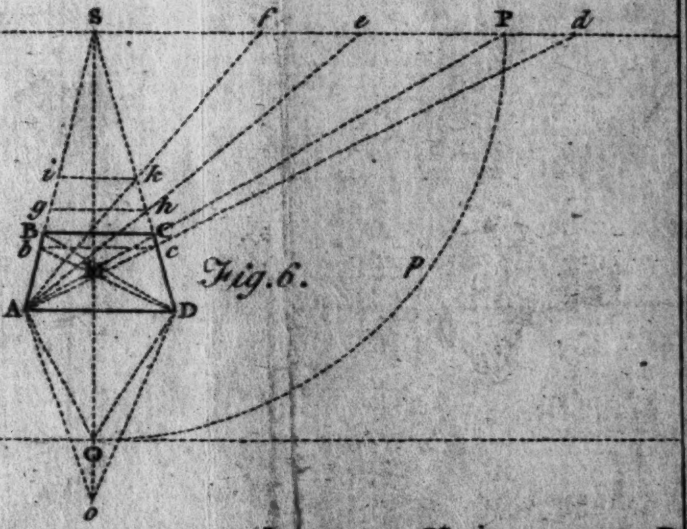
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Fig. 6.
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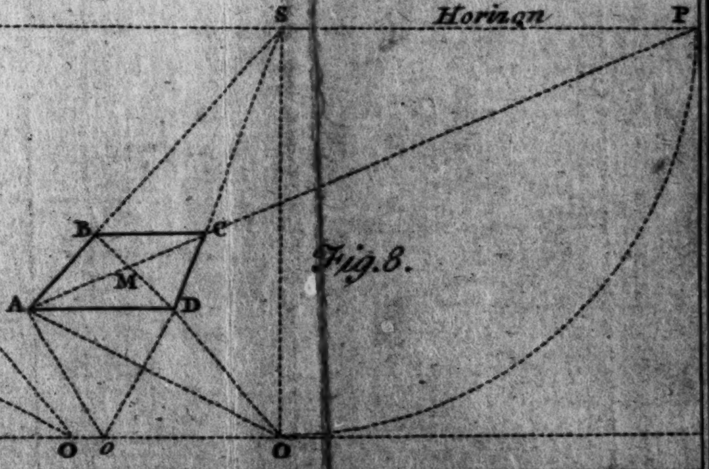
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Fig. 8.
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Fig. 1.

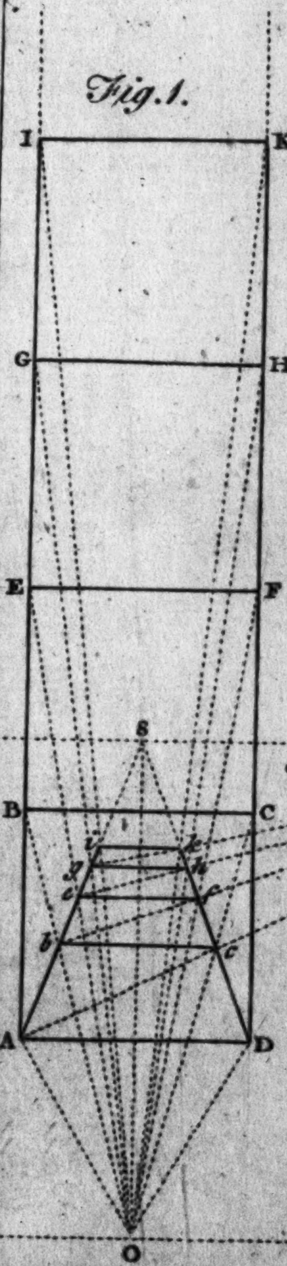
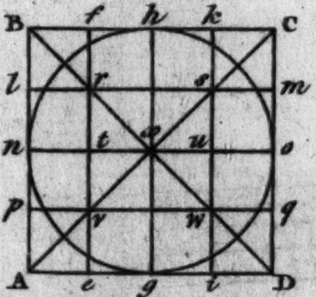


Fig. 1.

Fig. 2.



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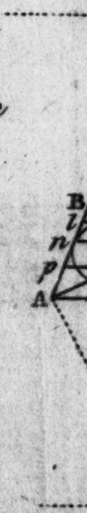

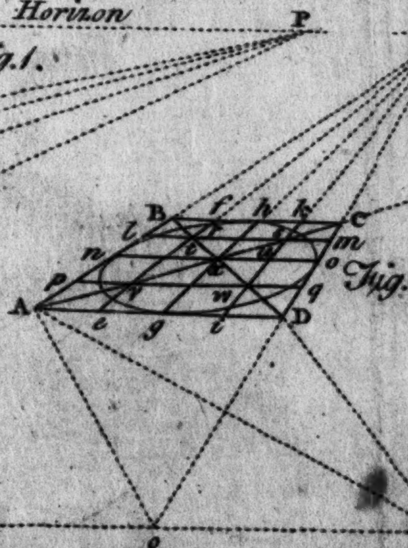

Fig.

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PLATE II.

Fig. 3.

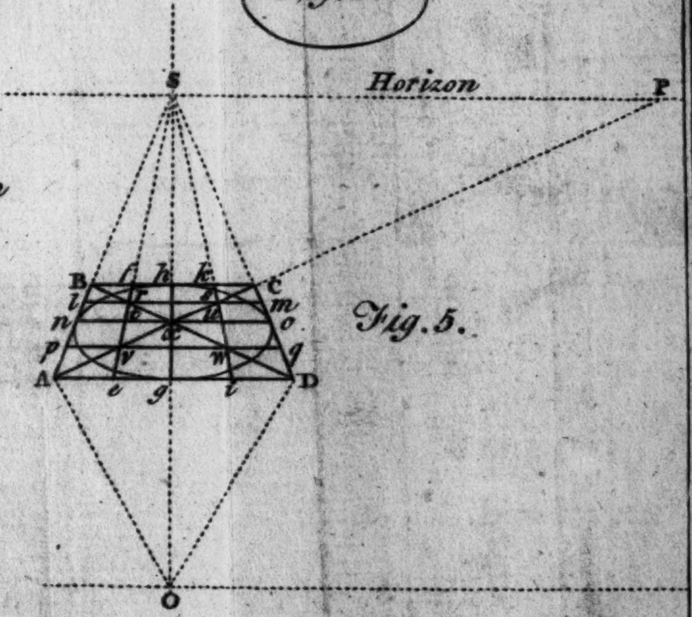
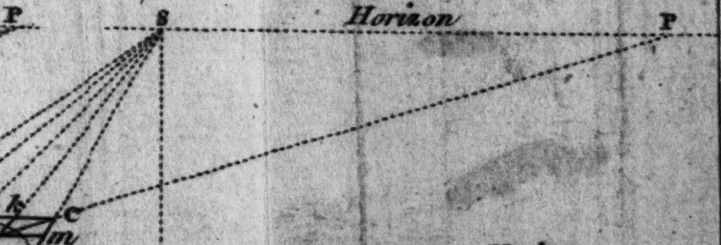


Fig. 5.



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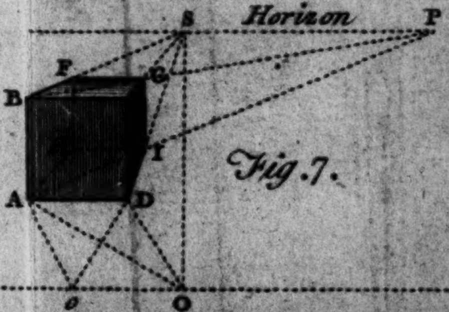

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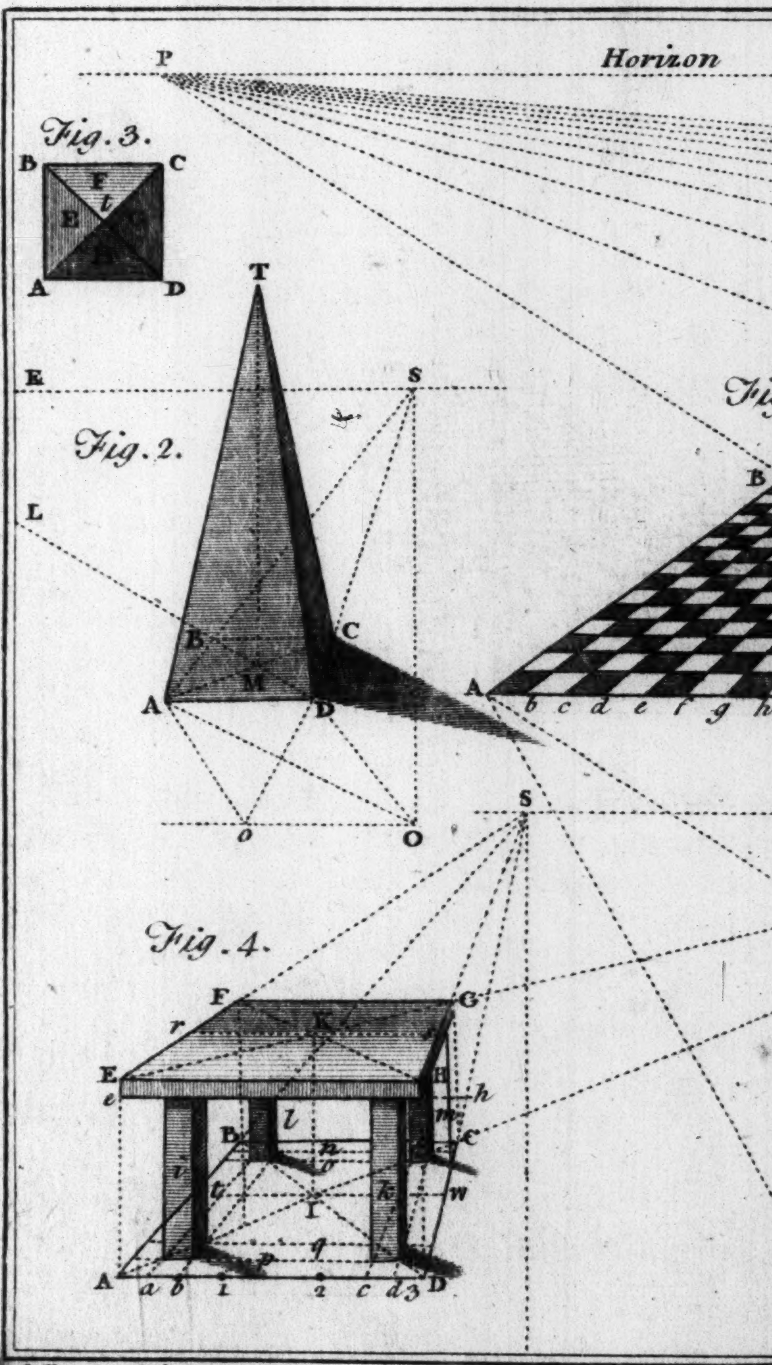

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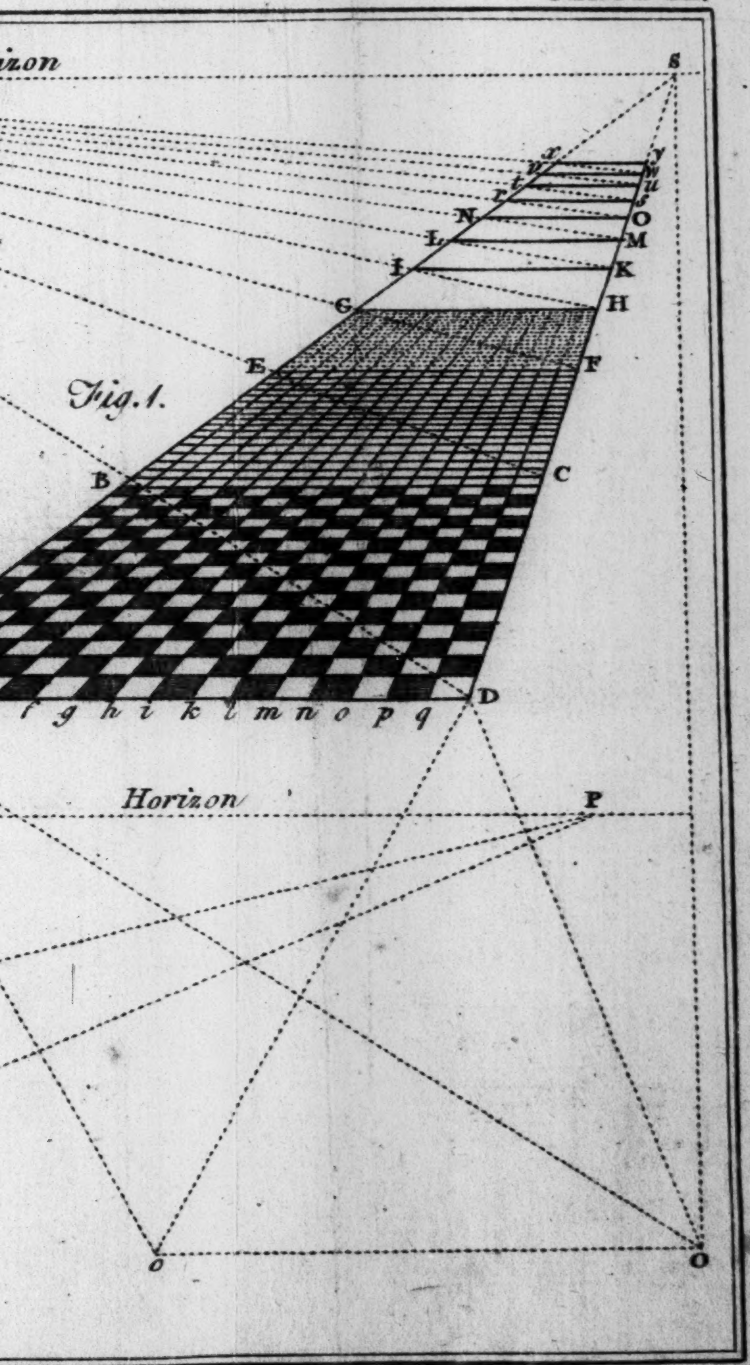
PLATE III.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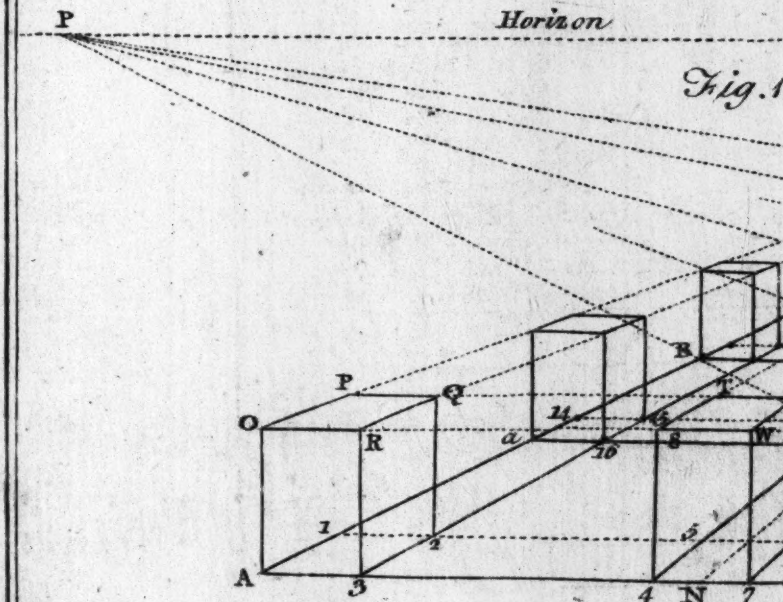

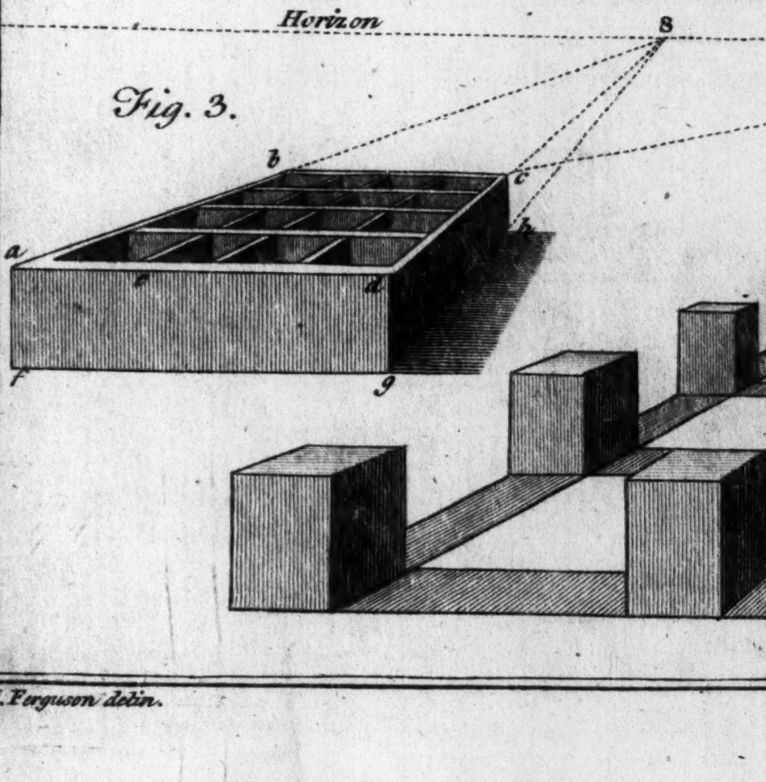

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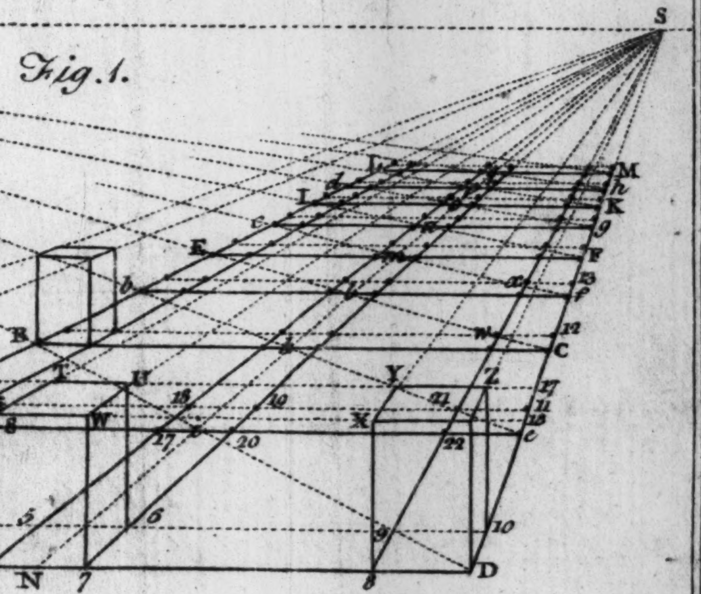
Fig. 1.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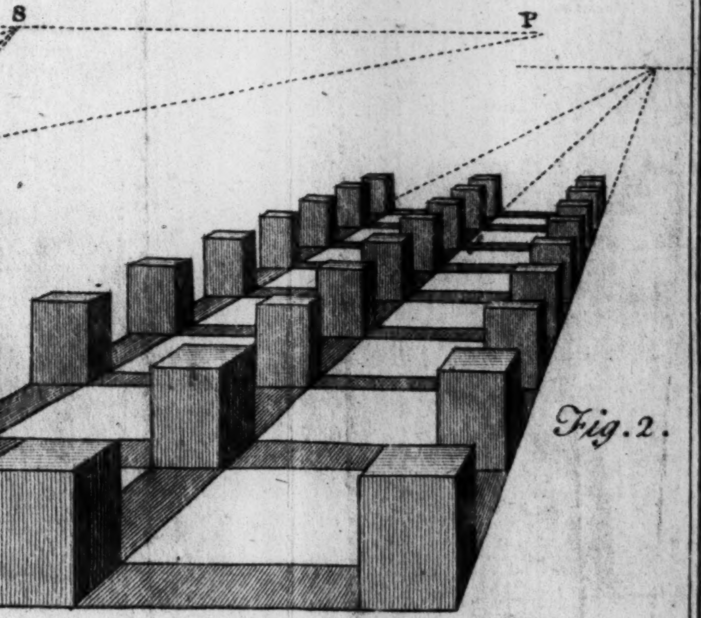
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Fig. 2.

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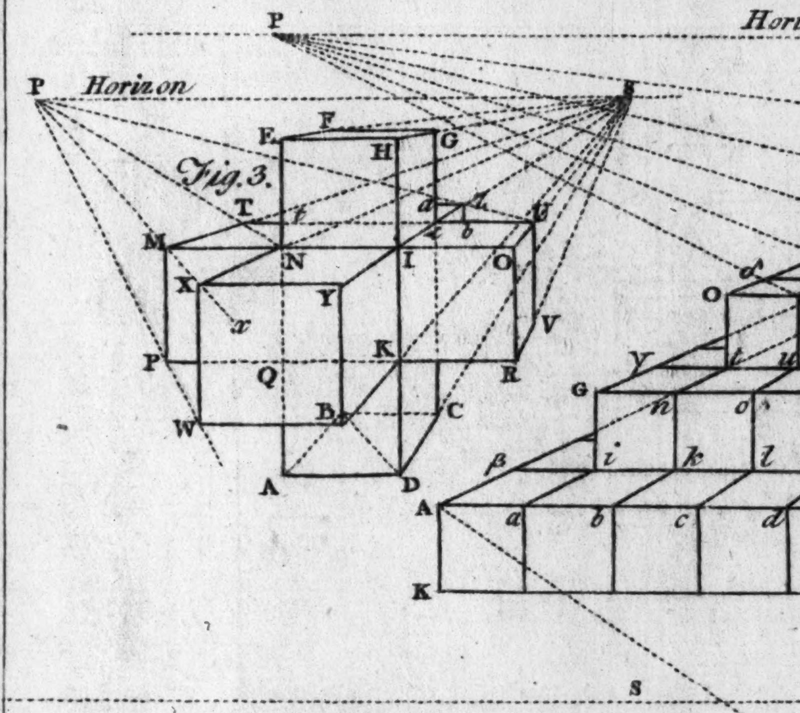

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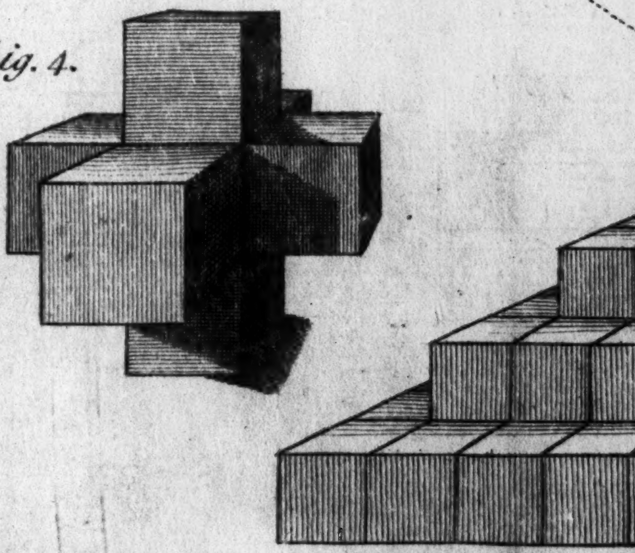

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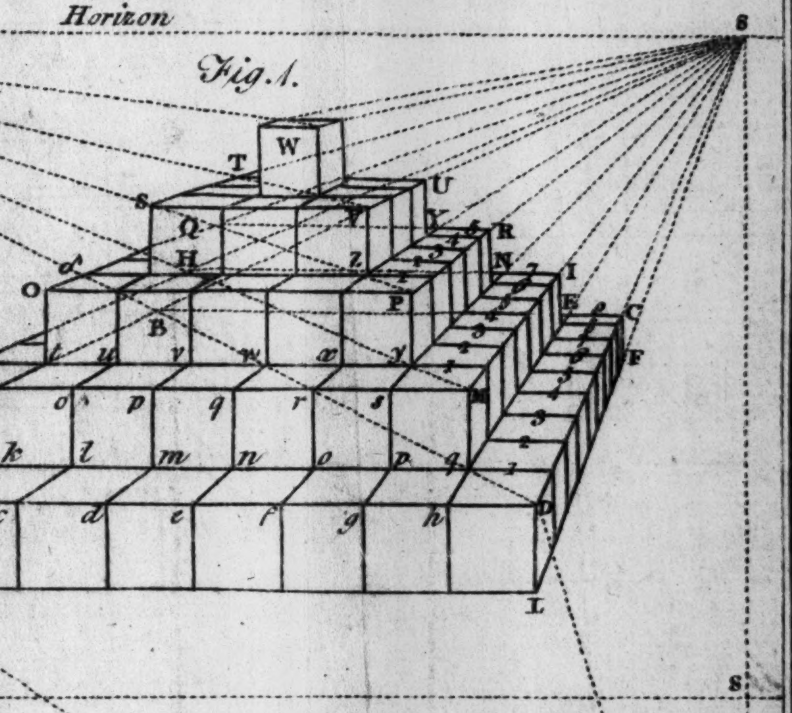
Fig. 1.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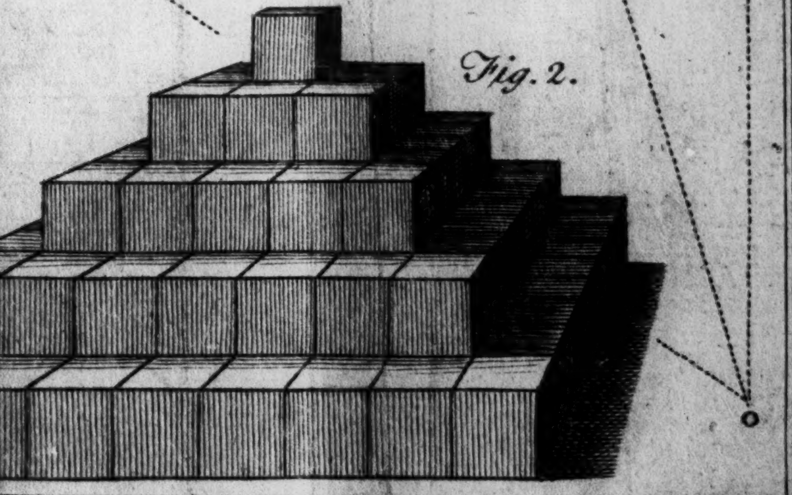
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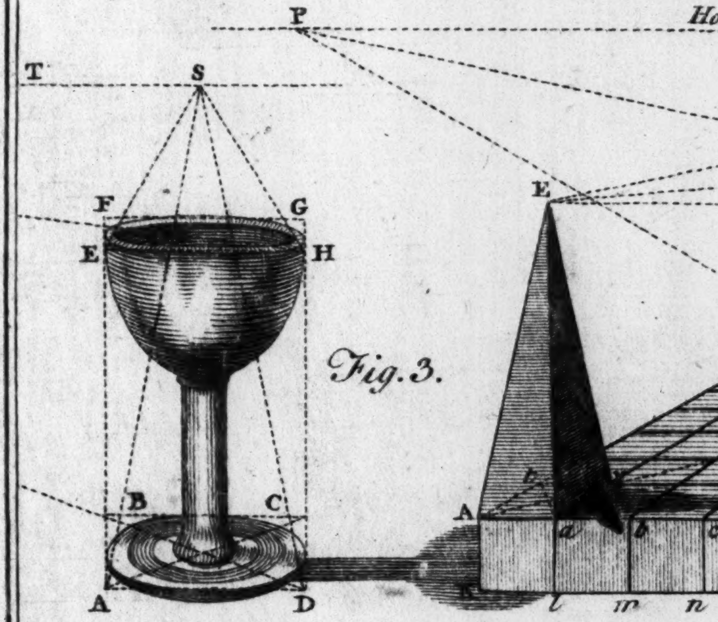

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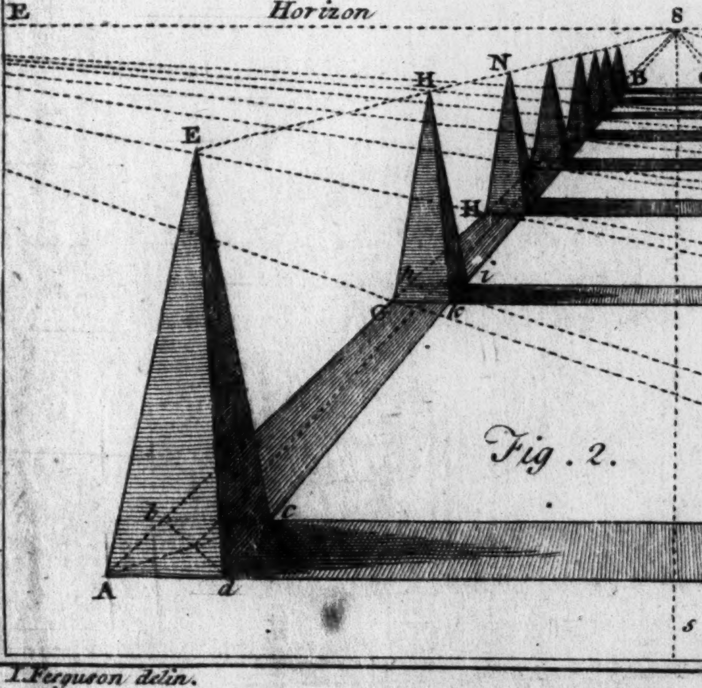

Fig. 2.

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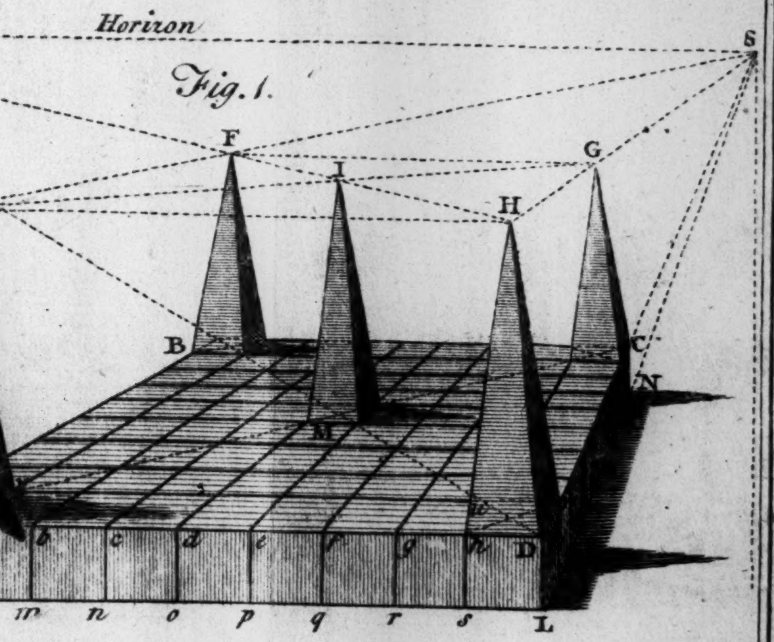
Fig. 1.



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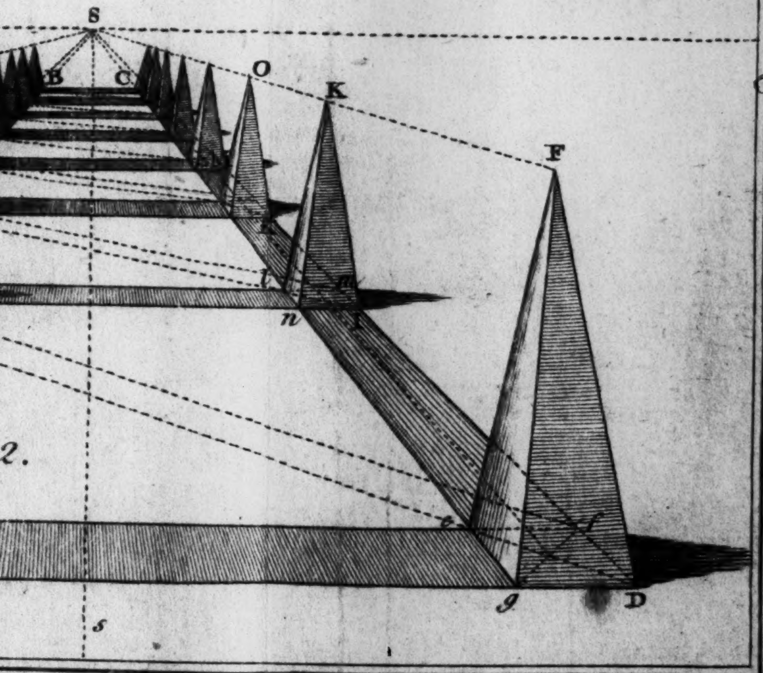

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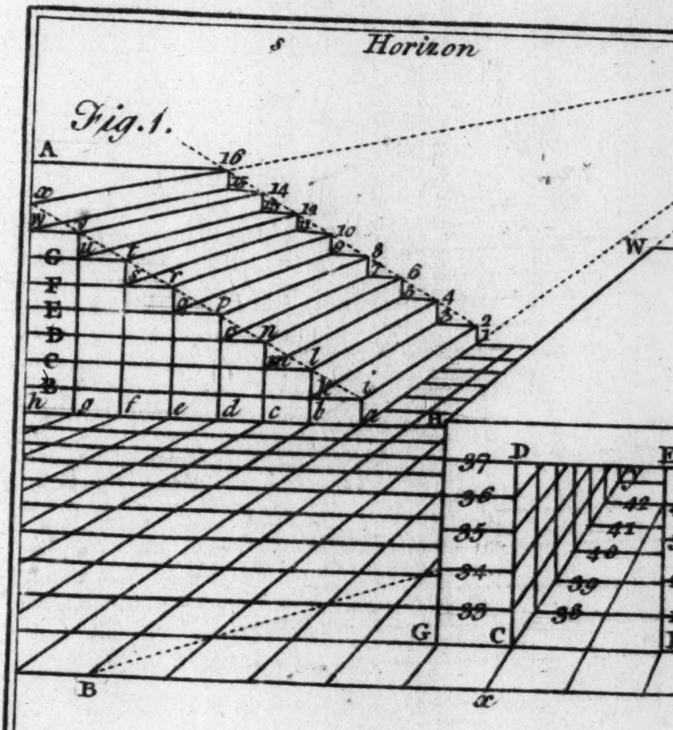

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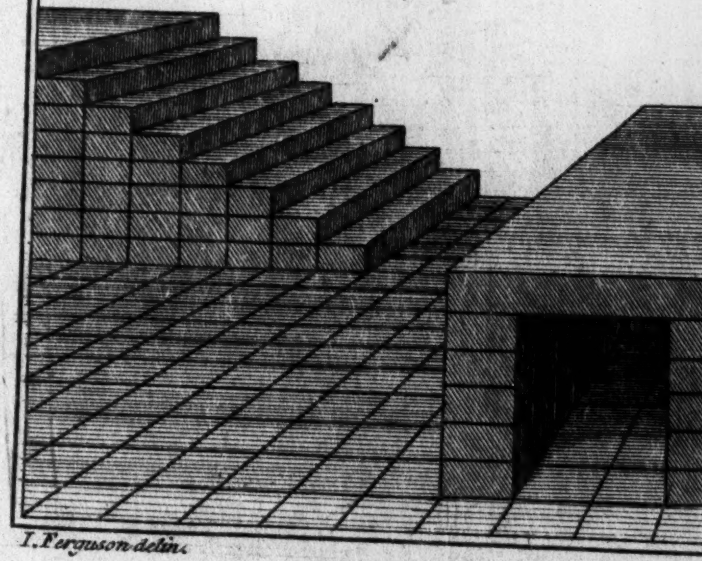

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Fig. 3.

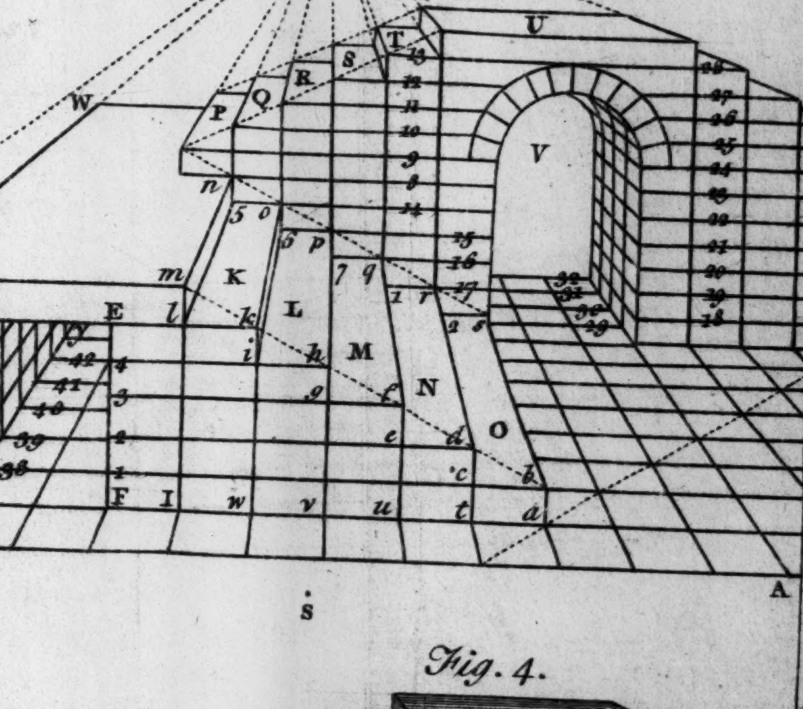
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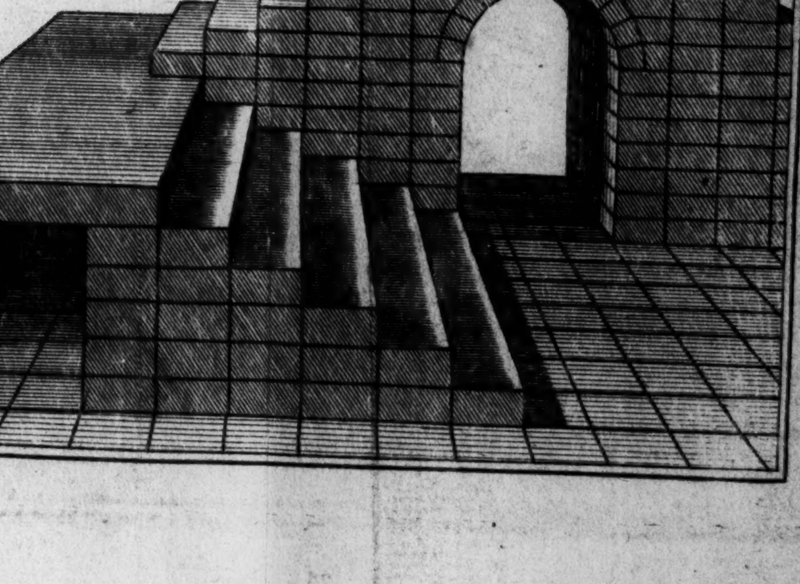
Fig. 4.



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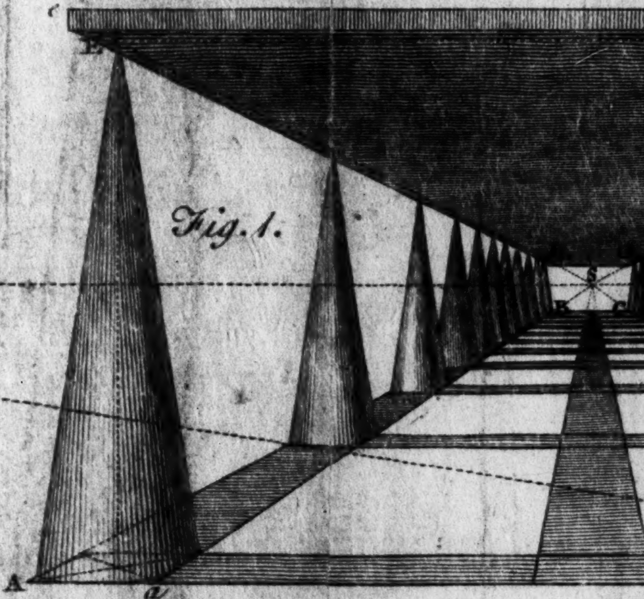

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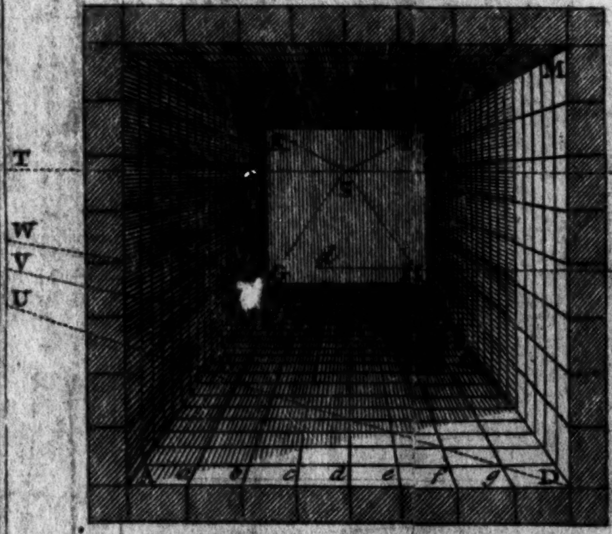

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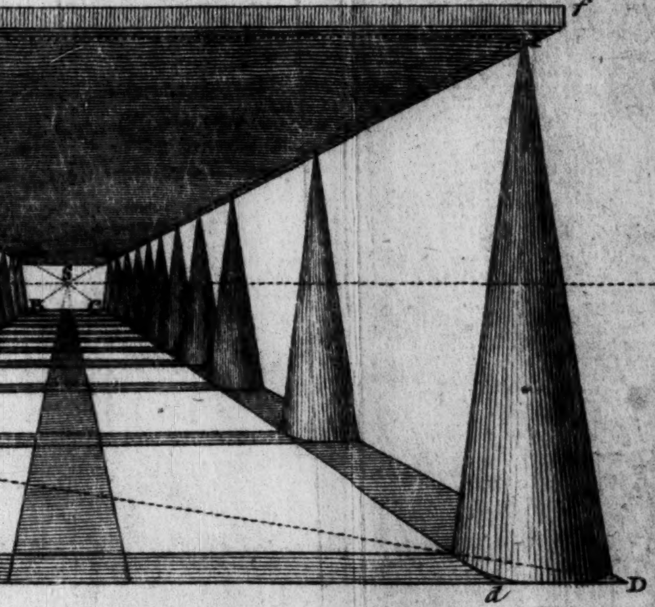
PLATE VIII.



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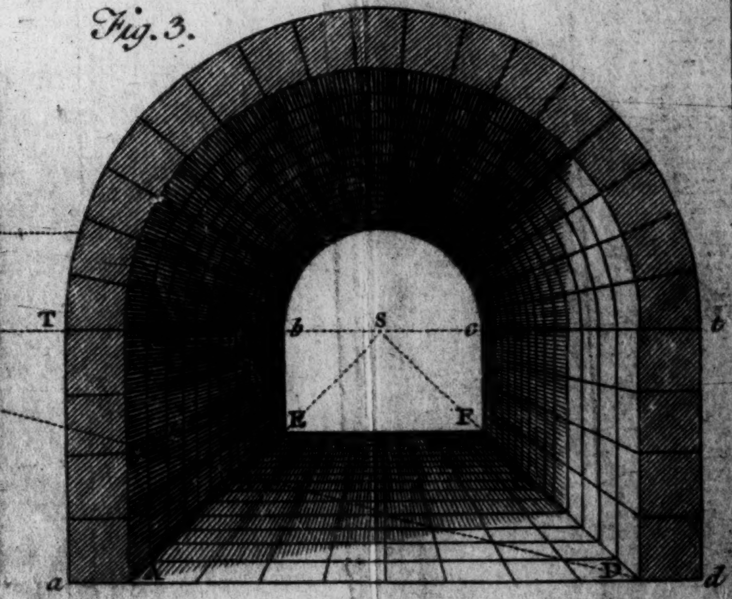
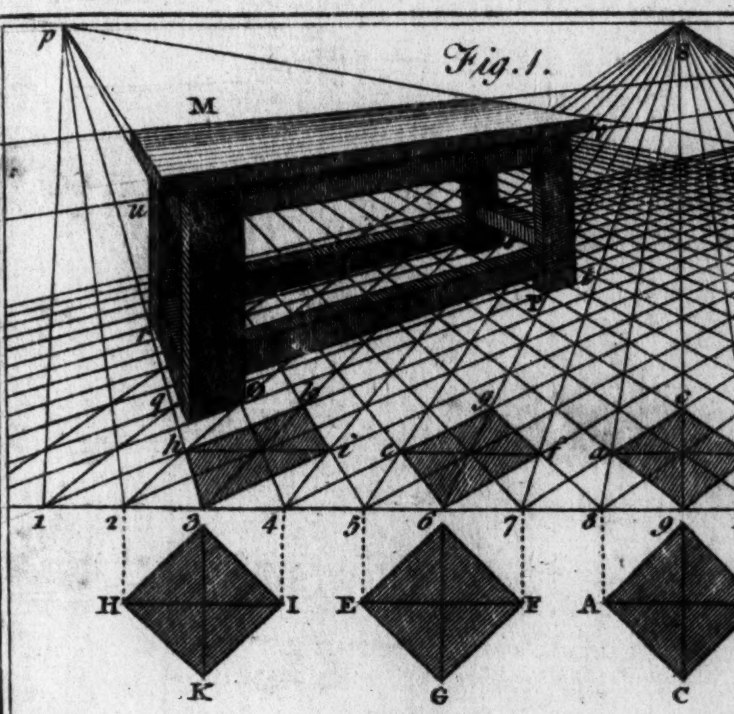


Fig. 1.



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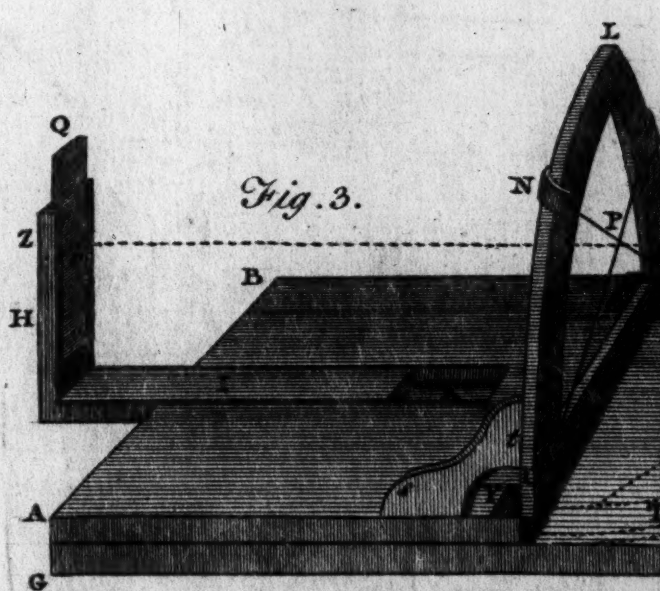

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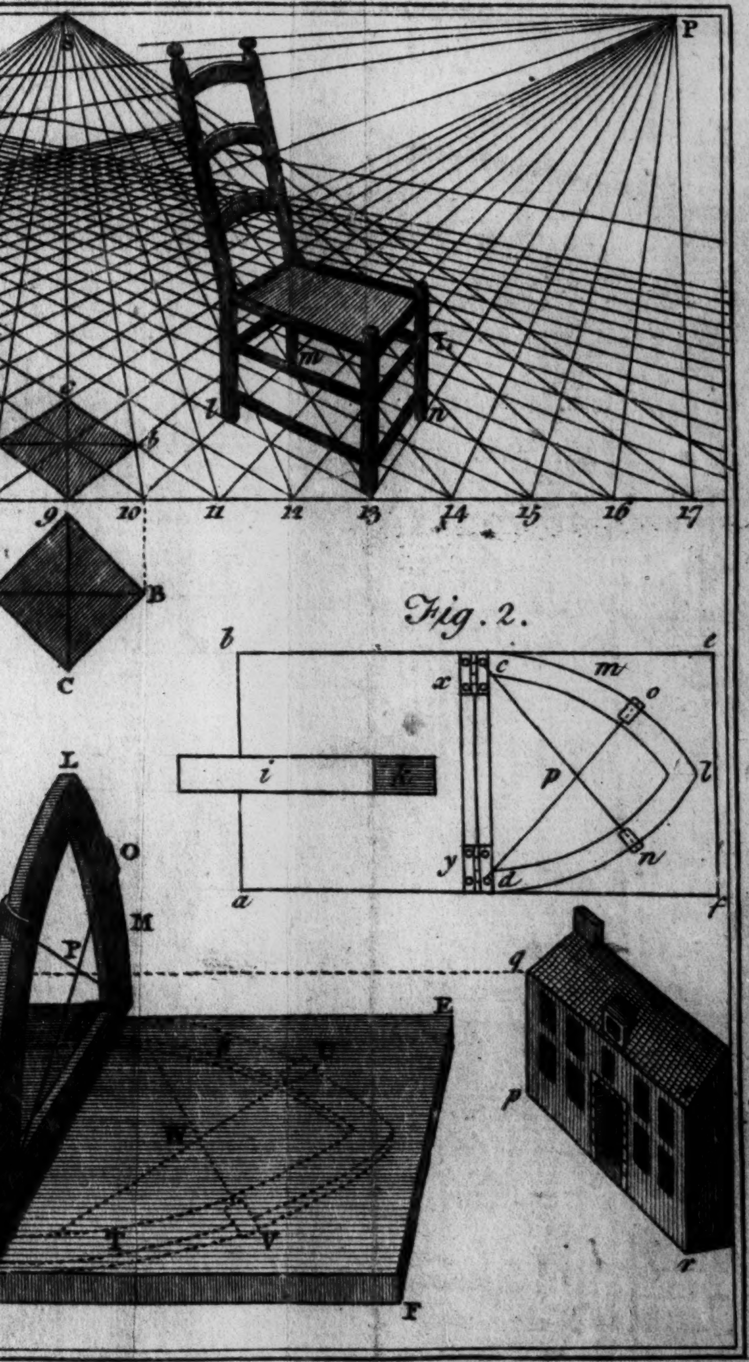
PLATE IX.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